METAL FINISHING

REPARATION, ELECTROPLATING, COATING

PUBLISHED FOR THIRTY SEVEN YEARS AS METAL INDUSTRY

...RY, 1947—45th YR.

SPECIAL

CLEPO BURNISHING COMPOUNDS

DEVELOPED BY CLEPO LABORATORIES

FOR ALL WATER CONDITIONS

These new Clepo Burnishing Compounds insure your obtaining maximum brilliance in a minimum burnishing time WITHOUT using an excess of burnishing compounds. With ordinary burnishing soaps an excess is needed to counteract water hardness before the soap is available for burnishing, also in extremely hard water no lustre can be obtained with ordinary burnishing soaps.

FOR WATER HARDNESS UP TO 40 ppm* for use with burnishing Shot. can also be used Without Shot if parts are Self-Rolling.

FOR WATER HARDNESS UP TO 1000 ppm* for use with burnishing Shot. These Compounds are so formulated that they work efficiently with Stone for Cutting down

CLEPO 160-A ⇐ for Aluminum, Brass, Bronze, Copper, Ferrous metals, Gold, Nickel—Silver and Silver. ⇒ **CLEPO 169-B**

CLEPO 87-A ⇐ for Ferrous metals where some cleaning action is needed in addition to burnishing. ⇒ **CLEPO 167-C**

CLEPO 162-Z ⇐ For Zinc Base Die Castings and zinc Electroplate. ⇒ **CLEPO 164-M**

* PARTS PER MILLION (1 GRAIN PER GALLON IS EQUIVALENT TO 17.1 ppm)

W.M.

FREDERICK **GUMM** *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N. J.

METAL FINISHING

PREPARATION, ELECTROPLATING, COATING

Founded as Metal Industry, January, 1903 by Palmer H. Langdon, 1868-1935

VOLUME 45 JANUARY, 1947 NUMBER 1

CONTENTS

DEPARTMENTS

COMING SOON

Information on electroplating rectifiers, giving advantages and data on various phase type units.

•

Disposal methods of cyanide wastes in the plating room reviewed with suggestions for proper neutralization.

Melamine plating barrel for use in all solutions as now being used in automobile plant explained.

•

Engineering applications of plated coatings; a brief review of various coatings used in industry.

Editorial and Business Staff

L. H. Langdon, *Publisher*
Palmer H. Langdon, *Assistant Publisher*
Richard A. Mozer, *Engineering Editor*
Thomas A. Trumbour, *Business Manager*
Joan T. Wiarda, *Advertising Manager*
George W. Gruppe, *Washington Editor*
John E. Trumbour, *Equipment and News Editor*

Publication Office

11 West 42nd St., New York 18, N. Y. Telephone: PEnnsylvania 6-0226

SUBSCRIPTION PRICES: United States, $3.00 and Canada, $3.00 per year. Other countries $7.50. Single copies 35c in U. S. and Canada, Foreign 75c. Please remit by check or money order; cash should be registered. Contributed articles, communications, etc. on pertinent subjects are invited. Their publication, however, does not necessarily imply editorial endorsement.

A NEW FINISH

and LEA plays an important part

With justifiable pride, Schlage Lock Company of San Francisco offers to the trade and to consumers its "LUSTER-SEALED" Lock with distinctive Satin Silver appearance. A fine piece of merchandise! But back of it was a lot of research with Lea Technicians helping in the development of the finishing method.

LEA Compositions prepare the surface of each lock for the final anodic finish. After the operation using LEA Compound, the parts are treated anodically in a suitable electrolyte to obtain a dense, adherent coating of aluminum oxide. This aluminum oxide, which forms the finish, is integral with the surface of the parent metal. It cannot peel, requires no protective lacquer or other covering which would scratch off. Success of this anodic finish, however, depends to a large extent upon proper preparation of the metal surface.

LEA is playing a vital role in the post-war era of metal finishing development. Perhaps you, too, need assistance in solving a finishing problem. Why not consult a LEA Finishing engineer? Send us the details of your problem, and, if possible, samples for testing in our laboratory.

SCHLAGE
"Luster-Sealed"
LOCK

THE LEA MANUFACTURING CO.

1-LM-1 **16 CHERRY AVENUE, WATERBURY 86, CONNECTICUT**

Burring, Buffing and Polishing . . . Manufacturers and Specialists in the Development of Production Methods and Compositions

VOL. 45, NO. 1 METAL FINISHING JANUARY, 1947
PREPARATION, ELECTROPLATING, COATING

Outlook for 1947

With the advent of the new year, metal finishing should develop more and more as the year progresses.

There should be a sharp increase in the number of job plating shops, especially smaller ones, for many men feel that the decorative plating field is a lucrative one and are already setting up equipment, although they have little or no background in electroplating.

Much more work will be done in the research field on decorative finishes and less on direct industrial applications of electroplating. Cleaning and pickling procedures will be more specialized for a given basis metal than heretofore, primarily because of the accent on cost-reduction and competitive methods. Brighter coppers should appear while cold bright nickel solutions with satisfying thicknesses and physical properties should be available for commercial applications. The religiously held chrome plating ratios will undoubtedly be loosened, for the electroplater is not so rigidly held to operating specifications on his contract work. Tarnish resistant alloys in the precious metal groups should appear in the form of proprietary baths, while lead, tin, zinc and cadmium should fade in the decorative picture. Electroforming should take great strides, particularly in phonograph record making, where equipment and techniques will reduce plating time considerably.

Abrasive polishing and buffing will be developed more than in the past several years by means of large installations of composition application methods, back-stand idler equipment and techniques, and a general improvement in abrasive methods; not only because the buff situation will ease, but because electrolytic polishing will come more and more to the fore as a supplement and in some cases a replacement, of hand polishing methods. Especially should this be true of large operations on a continuous scale.

Anodizing and magnesium treatments for appearance purposes will continue to develop, with the main effort being directed toward reduction of material and manufacturing costs in the hope of competing directly with normal finishing practice.

The rectifier field should enjoy some sharp competition due to the large influx of rectifier manufacturers, particularly selenium plate types; as a result, the electroplater should benefit by lower initial rectifier costs and more improved equipment. Tanks will be lined to a greater degree with synthetic insulators to keep solutions clean, while control equipment, both electrical and mechanical, should enjoy more applications.

The accent should be on more simplified testing equipment and procedures in both coatings and solutions, for the major governing factor is appearance, not thickness.

The long awaited flood of equipment and supplies should reach us, in spite of threatened labor controversies, in 1947.

Technical Developments of 1946

By Richard A. Mozer

Engineering Editor

Theoretical

MORE activity in the theoretical features of metal finishing was experienced than during the war years, at which time most effort was concerned with practical applications and engineering aspects.

The wartime shortage of chromic acid resulted in the *study of sulfuric acid additions* for maintenance of chromic acid anodizing baths. Slunder and Pray[1] found that there was severe corrosion hazard to steel, but that the weight of the aluminum oxide film was independent of the sulfate radical content, at least in the lower sulfate radical ranges, and that the process appeared to offer attractive savings in chromic acid.

Mahlia and Nielson[2] *evaluated the strength and stability of passive films* produced on stainless steel by various passivating treatments. Their tests showed that no passivation treatment conferred lasting protection to stainless steel when immersed in media which corroded the unpassivated metal.

The significance of *polarization in plating techniques* was investigated by Bandes[3] and the theory of various polarization phenomenon under optimum conditions was discussed. Comprehensive sketches and diagrams illustrated the theory.

Nickel transference was studied by Zitek and McDonald[4] and the transference number was found to be 0.366 to 40 degrees C in 0.1 N nickel sulfate solution. This amount was determined directly instead of by the usual difference method.

The theory of the *formation of black coatings* when zinc is anodized in chromate solutions between pH 2.5 and 4.5 was explained by Stareck.[5] The coating is basic chromium chromate, according to his findings.

Weisselberg[6] developed mathematical equations for *calculating voltage and current distribution* along the cathode by means of actual deposits on a cylindrical cathode inside which a control rod anode was suspended.

(*Courtesy Osborn Mfg. Co., Inc.*)

According to findings by Peach,[7] the *composition of chromium plating solutions* may vary from 150:1 to 70:1 between the chromate-sulfate radicals. He invesgated ductility and other physical properties of the chromium coating under his varying ratio conditions.

Anodizing

A procedure for *sulfuric acid anodizing* was outlined by Hendershott,[8] including a work flow sheet. *Dyeing procedures* after the anodic film is formed were given and recommendations for operation made. Herwig[9] gave detailed procedures for production of *anodic films on aluminum* which can be black dyed satisfactorily, including control of the dye bath.

Anodizing of magnesium in 5% sodium hydroxide solution was explained by Mason.[10] The film produced is corrosion and abrasion resistant and can be dyed. The coating is sealed in a chromate solution.

Janota and Button[11] *stripped anodized aluminum* by means of a dry mix consisting essentially of 80% hemi-sodium phosphate and 20% chromic acid, while Miller and White[12] *stripped oxide coatings* from aluminum by means of a solution containing 1% to 5% water, 5% to 40% hydrogen fluoride, the balance consisting of dioxan, alcohol and ether.

Corrosion Prevention

Evaluation of rust preventive oils containing polar organic derivative was found possible by Pilz and Farley.[13] Their findings were based on the contact angles formed by a drop of water on a horizontal oil-coated steel panel.

Durgin[14] *inhibited rust* on cold rolled sheet steel by squeeze rolling phosphoric acid directly into the sheet, thus giving it a coating of phosphate of 0.015 to 0.040 grams per sq. ft. of surface without impairing the luster of the sheet; White, Schwartz and Rouault[15] patented a *rust preventive* to inhibit fingerprint corrosion by the use of an oil soluble detergent, antirust agent and a volatile organic solvent.

Rust[16, 17, 18] patented several processes for *tarnish prevention* of a silver coating, based primarily on a solution of a fatty acid, the salt of a primary aliphatic amine, rinsing and drying thoroughly and buffing lightly. A *rust preventive* of wool fat partially saponified, wax, solvent, surface tension depressant and a homogenizer was patented by Ruedrich.[19] Several patents were granted Thomas and Ostrander[20, 21, 22] on their chromic-formic acid type *corrosion inhibitors*, while non-aqueous compositions of mineral oils and organic materials as *corrosion resistants* were patented by Fischer and Jenkins,[23] Miskel,[24] and Kleinholtz.[25]

Polishing

Cowley and McKnight[26] described the various steps for *carbon and stainless steel polishing* of surgical instruments in an informative paper, while the description of *polishing methods* for maximum efficiency was the subject of an article by Wells.[27] A discussion with recommendations was made by Faulhaber[28] on the required qualities of *polishing and buffing compounds* for best operation. Practical *hints on buffing* small quantities of small parts, which are a plague to most finishing departments, was made by Moore.[29] A description of equipment and accessories of *belt polishing equipment*, including resilient wheels, was the subject of a paper by Oathout.[30] He also gave comparisons and advantages of belt polishing over set-up wheels.

A *wire brush holder* for the end of a rotating shaft was developed by Fogliasso,[31] while Hall[32] patented a *rotary abrading wheel* with a plastic hub. Buell[33] used adhesive to obtain an *abrasive felted fibrous material*, by stitching outwardly from the center, Fowler[34] made a *backing wheel*, and Manderscheid[35] patented a *bushing* to press into preformed polishing wheels. A unique *abrading machine* having two adjustable belts so that work could be directed between them was developed by Murdock,[36] while Kistler[37, 38] was granted two patents, one on treating unvulcanized butadiene with abrasive to obtain a flexible rubber polishing wheel and the other for an abrasive, using iron sulfide, potassium fluoborate and abrasive grains.

Spray equipment for buffing compositions were developed by several manufacturers. An interesting discussion on this subject was made by Kellner[39] in which many advantages for the process were claimed, including flexibility, better control, greater savings, etc. Beaver[40] continued his discussion and investigation of *barrel finishing* methods of metal products after a lapse of several years. He went into tumbling, burnishing and deburring techniques using rotating equipment and the necessary lubricants and abrasives.

Recent applications, advantages and limitations, including relative costs of finished products by means of *electropolishing* was the subject of a paper by Faust.[41] Batcheller[42] *polished stainless steel electrolytically* using free sulfuric acid and acids consisting of chromic, vanadic, metavanadic, manganic and permanganic, temperatures in excess of 160 degrees F. A method for *electrolytically polishing silver* was developed by D. R. Turner.[43] He used the regular cyanide silver plating solution, making the work anode and using interrupted current from 4 to 7 times that of the normal plating cycle.

The selection and maintenance of *air equipment*, its design and a description of different types of fans was discussed by Warren,[44] while several patents were issued for *dustcollectors;* to Fischer[45] for one with a *water passage chamber*, to Lincoln[46] for one with *special dampering means*, and to Little[47] for a *gravity type unit* which separates the dirt by this means.

(Courtesy Oakite Products Inc.)

Cleaning

Smith[48] discussed the *acidic atmosphere test* devised for producing a type of corrosion on steel similar to that encountered in actual exposure. The effect of cleaning on the subsequent corrodability of the steel was determined with this test and was the primary consideration of the study. Hazel and Stericker[49] showed that when correctly selected *silicates* are used under closely controlled conditions for cleaning zinc and its alloys, attack and formation of deposits are eliminated. Their observations were substantiated by tests conducted by the authors. Spring, Forman and Peale[50] evaluated *alkaline cleaner performance* by sketching the water-break pattern on paper, dividing it into 100 squares and counting the squares free of oil. They posed the question of purchasing a more expensive cleaner to get better results at 140 degrees F as against a cheaper cleaner operating at the usual temperature of 180 to 210 degrees F and giving just as good results.

Hyler[51] went into equipment and methods for *metal cleaning*, while Harris[52] examined *films and surface cleanliness*, defining each, and holding that cleanliness is a relative term indicating that films may or may not be harmful to subsequent operations.

Advantages of *vapor degreasing*, solvents used in the process and health hazards connected with its operation was the subject of an informative paper by Black.[53] A patent was granted Campbell[54] on a process for *cleaning metals* to remove buffing or drawing compounds by having a bath in two layers, the lower being composed of grease solvent emulsion while the upper contained a grease solvent; upon removing from this solution, the work was sprayed with a combination of the two.

Wassel[55] developed a *tarnish remover* comprising primarily water, abrasive, chemical tarnish remover and metal wetting agent. Evans and Stolberg[56] won patents on *scale removal* by high velocity fluid being ejected from special jets, while Stine[57] devised a *piston cleaning machine* using rotating cleaners in a tank. Zinc and zinc bearing metals, such as diecastings, were cleaned by Szatyn[58] by a *continuous process* in a machine which operates at low pH on the spray type principle. Goldowski[59] *cleaned aluminum*,

(Courtesy American Pipe & Construction Co.)

primarily for welding, by using approximately 20% sodium sulfate, 10% nitric acid and the balance water; generation of the sodium bisulfate cleans the metal. Spence and Hooker[60] *removed oxides* from metal surfaces by means of a caustic alkali bath operated between 300 and 600 degrees C, subjecting the surface thereafter to a weak organic acid treatment.

Detergents for metals as developed by Hicks and Saunders[61] were patented, while Myers [62] devised a *detergent* non-irritating to the skin and having a flash point not lower than 115 degrees C. Also in the detergent line, patents were granted Kroll,[63] for a combination *detergent and wetting agent*, and Kroll and Weisberg,[64] for a *hard water detergent*. Turner[65] *cleaned wire electrolytically* by clamping and spreading wire coils out on an anode bar and immersing in a cleaning bath, while a *drum cleaning machine* operated by rotating drums with guide rolls was developed by Trager.[66]

A *strip cleaning machine* for metallic strip in a continuous process was patented by Croft,[67] several compartments holding the cleaning solution and the strip being delivered to the various section by a roller arrangement. Nowatius[68] developed a machine for *treating etched plates*, thereby removing soil from the etched surface.

Abrasive Blasting

Pettingil [69, 70] wrote a comprehensive paper on *abrasive cleaning* materials, methods and equipment in a series of two papers; his first dealt with *air blast cleaning* and his second with *airless techniques*. Keefer[71] was granted a patent for an *abrasive blasting* device; Heany[72] a *sandblast nozzle;* Archer[73] a *sandblast tool;* and Rasmussen[74] for a *sandblasting apparatus*. To permit only the required amount of grit to be ejected, Myers[75] developed a *control valve*, and Anderson[76] *sprayed abrasive* through special jets in a continuous blasting machine.

Pickling

G. B. Hogaboom[77] gave practical pointers on operation of a *pickling and bright dipping* plant for use on *copper-zinc alloys*. The chemistry of *acid pickling* was described by deLattre[78, 79] in two papers; his first dealt with regeneration of sulfuric acid baths and the effect of hydrochloric additions to lower the iron content below the point where it slowed down the pickling process, and his second was a description of balanced action baths containing hydrochloric and sulfuric acids. The iron sulfates were removed intermittently by freezing out at 20 degrees C, thus permitting the bath to be used indefinitely.

An investigation of the effect of *pickling* operation on the formation of dross in *hot-dip galvanizing* was made by Fisk and Pollack.[80] An interesting conclusion drawn was that with ordinary production rinsing methods, the film from a hydrochloric acid pickle was not rinsed off more easily than that from a sulfuric acid pickle, contrary to common belief. Planning a *pickling* room for a *porcelain enameling* plant was the subject of a comprehensive paper by Smith and Carno.[81]

Several *pickling inhibitor* patents were granted. For dilute solutions of non-oxidizing mineral acids, Petersen[82] patented an *inhibitor* using di-ortho-xenylthiourea and sodium sulfate, and Hill[83] used formaldehyde, hydrogen sulfide and a melamine for *inhibiting pickling solutions* for ferrous metals. Other *pickling inhibitor* patents were granted to Bolton,[84] Johnson,[85] Hill, [86, 87] and Saukaitis.[88]

Coatings

Young and Struyk[89] deposited *nickel-cobalt alloys* from chloride solution, using a buffer, and obtaining a bright or semi-bright alloy as desired. The authors established conditions under which good deposits could be obtained. *Lead-tin alloy* plating from fluoborate baths was successfully performed by Carlson and Kane,[90] using either alloy or dual anodes, with necessary modifications for successful plating of bearings. *Copper-tin* deposits from the cyanide-stannate bath, using dual anode circuits, were very satisfactory as stop-off in nitriding, according to a paper by Struyk.[91] The alloy eliminated soft spots which are occasionally found by the use of pure tin deposits, primarily because the tin melts at temperatures below the nitriding point.

Diggin[92] gave advantages of a system of *regenerative plating*, using anodes in the plating tank and regeneration of solution in another tank, and having diaphragms around the cathods. Two papers concerned with common *plating bath troubles* were given by Sedusky and Mohler.[93, 94] The authors outlined causes, effects and trouble elimination in a variety of plating baths.

The plating of *carbide powders*, essentially for use on tools, was developed by Cottrell;[95] Diggin[96] contributed a paper on the classification of *impurities and sources of contamination*, together with procedures for purifying the commonly used plating solutions.

In a series of papers Ollard and Smith[97, 98, 99] went into the plating of *die castings*. This was an excellent review of English methods covering control, purifica-

tion and maintenance of the various baths. Mort[100] gave calculations of *terne deposits* and conversion factors for determining thickness of plate.

Burns[101, 102, 103] plated a *mixture of metals* by means of an aqueous ammoniacal solution of the various metal ammonia salts, obtaining two patents, and Wick[104] patented an apparatus for plating *magnetizable ball bearings* by means of rolling the balls between a magnet and a non-magnetic cathode bar.

Purification of *zinc electrolytes* by precipitation methods was successfully performed by Hendrickson.[105] He contacted the electrolyte with zinc dust coated with *copper and indium*, while Griffith and Hendrickson[106] obtained similar results by coating the zinc dust with *copper and tin*. In a discussion of *solution purification*, Diggin[107] described methods of purification and the effect of impurities on the deposit.

Gaver[108] used a plating bath with an aqueous solution providing ions of the metal to be deposited and a *metal starchate*, the latter being the reaction product of starch and an alkali metal. An apparatus was designed by Mathews[109] for plating *bearing shells* for crankshaft bearings and Ruben[110] secured a patent on a *continuous plating process* for wire or strip.

Aluminum

In *plating on aluminum*, Meyer[111] gave an interesting description of the *zincate* process, explaining surface preparation and subsequent plating. Close[112] looked into the *Krome-Alume* process of plating on aluminum, describing the method in full and explaining the technique by which the oxide film formed prior to plating must have definite characteristics in order to obtain adherent subsequent deposits; a work flow sheet was also included. Another enlightening paper was given by Raskin[113] for *plating on aluminum*. He described the *zinc immersion* process in full, giving formulas and work flow sheets.

Chromium

Corrosion studies of *electrolytic chromium* by Hackerman and Marshall[114] showed that attack appeared first along the crack network system. Moline[115] investigated *chromium plating* of 13% chromium steels; his studies showed improved salt spray resistance; even though deposits were quite thin. An interesting discovery was that the corrosion resistance *decreased* as the deposit thickness was *increased* up to a certain point, after which it increased and leveled off.

A paper by Ollard and Smith[116] described *chromium plating* practice in the facing of press dies; procedures and control of English methods were given. Crowder and Welch[117, 118] investigated the *hard chromium* plating practices in the plastics industry. They discussed surface preparation, anodes, throwing power and gassing. A *chromium plating bath* was designed by Wick[119] for depositing hard, dense malleable chromium with high resistance to impact. The bath contained chromic acid and sulfate radical, 3½ to 7½ grams of the latter per liter of electrolyte, using a minimum current density of 700 ASF and a temperature of 60 to 90 degrees C.

Nickel

Roehl[120] outlined procedures of *nickel plating zinc-base die* castings, stressing surface finish in die casting technique. In a series of papers on *nickel plating* sponsored by the American Electroplaters' Society, Mattacotti[121] investigated *cold and soft deposits;* Phillips[122] discussed the *Watts type baths;* Martin[123] checked *organic type brighteners;* Diggin[124] explained *alloy type bright nickel baths;* Wesley[125] looked into *chloride type baths;* and Pinner[126] examined *high speed nickel electrolytes.*

Brown[127] plated ductile *bright nickel* from an acid nickel bath by adding thallium sulfate and an aryl organic compound. A patent was granted Kosmin[129] on a *bright nickel* bath using nickel sulfate, nickle chloride, boric acid and an organic brightener composed of polysulfonates of the benzenes. Freed and Stockler[129] plate *bright nickel* by the use of a thiourea as a brightening agent in the common acid nickel plating solution.

Black[130] explained a *nickel-zinc alloy* coating process in which nickel is plated from a standard bath, covering the nickel with a deposit of zinc and heating both deposits at 700 degrees C to alloy the metals. The resulting coat has good adhesion, is smooth and withstands various drawing strains. Freed[131] plates a *lustrous deposit from* a bath having a mixture of nickel sulfate, nickel chloride, cobalt salts and a sulfonated aryl aldehyde as brightener. A complete bibliography of electro-deposited *nickel alloys* was contributed by Diggin and Kardos.[132] All alloys of nickel for plating in baths were listed, and patents, articles and books in the literature were given. Brief notes were made on each listing.

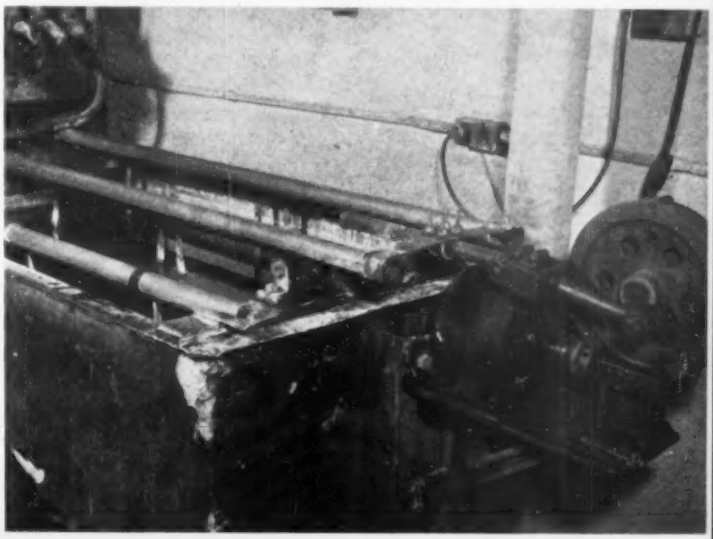
Precious Metals

A summary of *gold plating* methods was made by Haberman.[133] Formulas for various baths by immersion and by electrodeposition were given, as well as the necessary equipment.

Brenner and Olsen[134] treated *rhodium plating* solutions with potassium ferrocyanide in slight excess to precipitate metal impurities which affect reflectivity of the rhodium. The excess ferrocyanide was precipitated by the addition of ferric sulfate and the precipitate removed from the bath.

Hart and Heussner[135] explained the production of *silver plated bearings* for aircraft engines; they also described tests performed to check adhesion and

(*Courtesy Adel Precision Products Corp.*)



quality of the deposit. A review of recent trends and developments in *silver plating* was made by LoPresti,[136] and Hess and Nippes[137] found that by *silver plating steel*, a good bond was produced between *aluminum and steel* by welding techniques. Their investigation includes plating methods to obtain maximum strength of bond.

Tin

Tin plating was done by Andrews[138] from an acid tin bath composed mostly of organic materials. An *alkaline tin plating* solution was patented by Blackburn,[139] and an *organic addition agent* to an acid bath was developed by Schweikher.[140] Baier[141] applied a *tin alloy* from an alkaline tin alloy solution using a pure tin anode and an anode of a dissimilar metal, applying the anodes alternately.

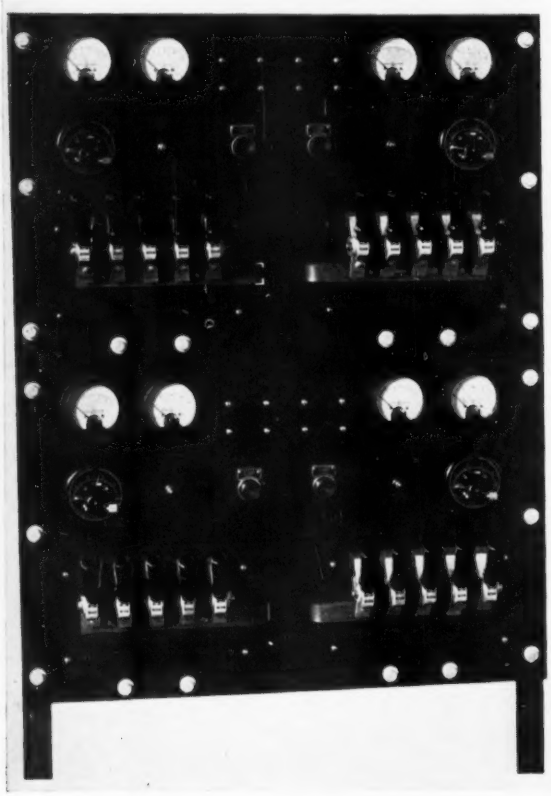
Zinc

Roebuck and Brierley [142] explained the high speed *zinc plating* of wire by the *Tainton* process, using insoluble anodes and replenishing the zinc content by the leaching of zinc ores. Wick[143] patented an *acid type zinc plating bath*, using a minimum current density of 750 ASF, while Bray and Howard[144] developed a *bright zinc acid solution*, plating in the range of 600 ASF. Gray[145] added small amounts of anthraquinone-sodium-sulfonate to *acid zinc solutions* to obtain better plating conditions.

Miscellaneous

Description was made by Cobb[146] of the growth of "whiskers" (needle like growths) on *cadmium deposits;* their properties were investigated and theories as to the causes of growth advanced.

(*Courtesy Columbia Electric Mfg. Co.*)



Brown and Hurley[147] deposited copper, zinc over the copper in the ratio of approximately 70% copper to 30% zinc, heated the coating to the alloying temperature and thus formed a *brass coating* over electrodeposited copper.

Martz[148] plated *indium* by use of an aqueous acid solution composed of indium fluosilicate, indium fluoborate and indium fluoride.

In the field of *lead and lead-tin alloys*, Dukose[149] studied the effect of *glue* in lead baths upon characteristics of the deposit and found that an increase in glue concentratation resulted in better covering and throwing power and increased corrosion resistance, especially in salt spray. *Lead-tin alloys* in the range of 5% to 6% tin were found by the same author to have better corrosion resistance than pure lead deposits or alloys with higher tin content.

A system of purifying *manganese plating solutions* was patented by Hunter,[150] while Koster[151] in an informative paper purified sulfate solutions for *manganese plate* by the use of hydrogen sulfide. The author found that satisfactory deposits were obtained at relatively high current densities and over long periods of time; he also stated that current efficiencies and stability are somewhat improved by addition of a hydrophosphite or hypoborite to such solutions.

Hot Dip Coatings

Grupe[152] obtained a patent on a process for *hot tinning selective areas* by means of fluxing only those areas desired to be tinned. Equipment for *galvanizing* sheet, strip, or wire in continuous process under controlled temperature conditions was designed by Mauger and Ward,[153] while Ward[154] himself patented a *continuous electro-galvanizing* method. Cresswell,[155] in a paper on *hot tinning*, discussed the effects of the process on cast iron. Tests indicated that by following a pickle with a dip in fused potassium and sodium nitrate, and using a flux composed of the eutectic of zinc and sodium chloride, best results of the tin coating were obtained.

Electroforming and Metallizing Non-Conductors

Stating that the building up of parts by electrodeposition of iron was a laboratory method until less than 10 years ago, Clauser[156] made a survey of *electroforming* processes. In it he included the various types of articles which can readily be electroformed and a discussion of the methods and limitations of the process. Wise and Vines[157] patented an electroformed reflector of concave-convex type, using copper, silver and rhodium. Upon the rhodium a non-noble backing layer was deposited and the rhodium and silver layers separated, making the rhodium coating the reflector.

Shomberg[158] gave some laboratory notes on the use of graphite and metal powders in *metallizing nonconductors.* Practical procedures for *preparing plastics for plating*, including cleaning, roughening, sensitizing and silvering, was contained in a paper by Narcus.[159]

Alexander and Cranstone[160] secured a patent for *metallizing moisture absorbent materials* in sheet form by means of a continuous process in a vacuum; while Weinrich[161] also obtained a patent for *vacuum metallizing*. Benner[162] described the *vacuum evaporation* method of coating plastics with gold, silver, aluminum, chromium, nickel, tin and platinum.

Hamel[163] *coated paper articles* with aluminum by wetting the surface with glycerin, then spraying fused aluminum on the wetted surface. A method of forming *reflective aluminum coatings* on glass was patented by McRae.[164] *Thermal evaporation* in a vapor, oxidation of the layer so deposited and burnishing of the final coat was essentially his process.

Metal Coloring

Clingan[165] *blackened stainless steel* by immersing the work in a sodium and potassium dichromate bath in the temperature range of 400 to 500 degrees C. King[166] patented a chromic, formic acid and soluble formate solution for *coloring zinc and cadmium*. After treatment and while the coating was still wet, it is dyed with an organic dye to obtain both color appeal and corrosion resistance.

Maher and MacStoker[167] gave two interesting papers on the *coloring of brass and bronze*. Techniques, surface preparation and formulas were covered, including methods of correcting many coloring faults. Schulze[168] outlined the preparation of ferrous and non-ferrous metals for *black oxide finishing*.

Testing

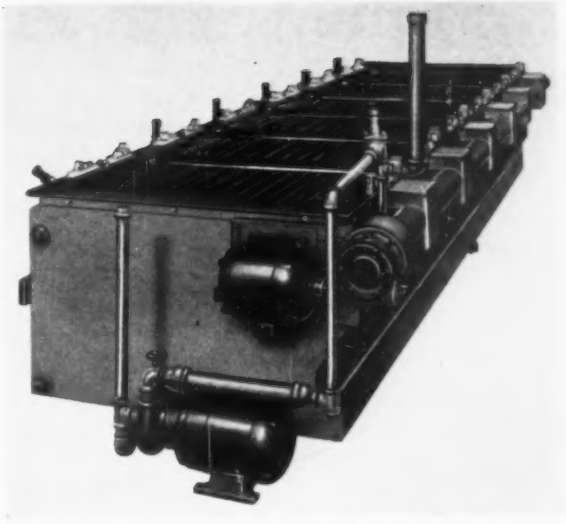
Cupples[169] measured *surface tension* of an unknown solution by the method of maximum bubble pressure, comparing it with a liquid of known surface tension.

Practical *conductivity measurements* by Mohler and Sternisha[170] gave control information on alkaline cleaners as well as a determination of the effectiveness of rinsing facilities.

The hydrochloric acid *drop test* method for determining the thickness of chromium deposits was investigated by Spencer-Timms.[171] It was found that the process was suitable for deposits up to 0.00006" thickness; the temperature coefficient was appreciable, while the accuracy was in the order of plus or minus 20%.

Clabaugh[172] perfected a method of determining *gold deposit thickness* by punching out a test sample of predetermined area, dissolving the basis metal, decanting, dissolving the gold in aqua regia and determining the amount with a spectrophotometer using o-tolidine as the color producing reagent. *Identification* of all common plated coatings by simple shop techniques without the use of elaborate laboratory equipment was given by Black and Sinner.[173]

Ferguson and Stephan[174] gave a description of the quantitative methods of *testing adhesion* of electrodeposits, and Ferguson [175, 176, 177] published a series of papers on the description of various *adhesion tests* reported to the research director of the American Electroplaters' Society; comments from various sources on methods for measuring degree of adhesion;



(Courtesy Hanson-Van Winkle-Munning Co.)

and further information on methods of testing adhesion characteristics.

Identification and estimation of rust on iron and steel was made by Gibadlo.[178] The method consisted of selectively dissolving the oxides in a solution of potassium tartrate and potassium hydroxide in water, then determining the oxide content quantitatively. Todd[179] developed *corrosion testing equipment* for the laboratory, which included temperature and pressure controls.

Determination of cobalt in the presence of iron and nickel, using a photoelectric colorimeter, was developed by Hixson and McNabb.[180] Zentler-Gordon and Roberts[181] devised the control of *copper and zinc in brass plating solutions;* polarigraphic methods were used effectively on the deposit. Silverman, Stewart and Davies[182] instituted a colorimetric method of determining *molybdenum in zinc cyanide plating solutions.* The authors stated that determination of molybdenum in aqueous solutions in the order of 3 mg. per 100 ml. was feasible; iron and organic wetting agent did not interfere. Foulke, Meyer and Case[183] explained methods of *impurity determination* in plating solutions. The theory of colorimetric technique was given, and analysis for metallic impurities in nickel plating solutions developed. Serfoss and Levine[184] continued the research and detailed developments in *colorimetric techniques.*

Surface roughness testing equipment, using electrical signal methods, was patented by Brown.[185] Herschman[186] designed a *roughness tester* by photoelectric comparison methods; Coss[187] was granted a patent for a *roughness measuring* instrument; and for a magnetic type *surface roughness* testing machine, Shaw[188] won a patent.

Miscellaneous

Hall and Hogaboom[189] reviewed the *technical developments and patents* of 1945. Silman[190] touched upon some of the uses and potentialities of *plating in the automotive industry* in England; his survey indicated English practice was years behind American.

Blum[191] listed *health hazards* in the plating industry

(*Continued on page* 93)

Plating with Platinum, Palladium and Rhodium

By H. M. HABERMAN

New York, N. Y.

Platinum

PLATINUM is a white metal with a grayish tinge having a specific gravity of 21.3 and a melting point of 1775° C. It takes a high polish and is impervious to tarnish and oxidation at temperatures up to 400° C. It is as soft as copper, malleable, and very ductile and is unaffected by ordinary acids, but is soluble in aqua regia and in concentrated sulphuric acid after long boiling. When properly applied as a plated coating, platinum is just a little softer than chromium and will withstand abrasion to a much higher degree than silver.

Although satisfactory platinum plating baths are now available, for many years it was difficult to obtain deposits which were bright enough to warrant extensive plating with this metal; its use has been restricted almost entirely to the plating of jewelry and electrical contact points. But even in these applications platinum has been displaced to a large extent by rhodium. Thick coatings of platinum are difficult to obtain, and thin coats are not too satisfactory as protection against acid or fumes because of fine cracks present in the plating as a result of contraction during deposition. In addition, the action of hydrogen, which is usually deposited on the work along with the platinum, frequently causes the finish to be hard and brittle and very difficult to polish. However, platinum is relatively abundant as compared with rhodium and that fact alone will probably encourage its return to favor and increase its industrial use.

A well-known platinum bath, originated by Pfanhauser, has the following composition:

Diammonium phosphate	2.2 ozs.
Disodium phosphate	13.4 "
Chloro-platinic acid	0.535 "
Water to make	1 gal.
Operating temperature—Close to boiling point.	
Voltage	3 to 4 volts
Current density	9.3 amps./sq. ft.

The chloro-platinic acid is boiled with the diammonium phosphate for a considerable time. As the boiling progresses the color changes from an orange-red to pale yellow because of the formation of a complex amino-phospate of platinum. Since insoluble platinum anodes are used, the bath must be replenished by adding chloro-platinic acid and boiling again with the addition of ammonia or ammonium phosphate. This bath will operate satisfactorily for a short while, but as it operates, the deposit grows cloudy and gray. Several other deficiencies are to be noted as well. First, since the bath must be replenished, the chloride content continually increases until the deposit becomes black and powdery. Second, the solution contains a very small proportion of platinum, and is therefore suitable only for flashing. Third, a yellow precipitate forms at the anode, and since this precipitate is insoluble, frequent filtering must be resorted to. Finally, because the cathode efficiency of the bath varies, ordinary controls over the thickness of the plating are not adequate, and it is necessary to halt operations periodically and weigh the product to insure keeping within the required limits of thickness.

Some years ago Keitel and Zschnieger suggested the use of platinum in the form of diamino-nitrite and such a bath has been giving excellent results in the form of bright and satisfactory work ever since. The following formula, an improvement on the original solution, covers what is known as the P-salt bath*:

Ammonium nitrate	100 grams
Sodium nitrite	10 "
Platinum as diamino-nitrite	10 "
Ammonia	50 c. c.
Water	1 liter
Operating temperature	95° C.
Voltage	4.5 volts
Current density	55 to 120 amps./sq.ft.

The platinum nitrite is dissolved by heating in a 5% solution of ammonia and then added to the bath. The chief advantage of this bath is that the inert products formed as a result of electrolysis are no longer chlorides and therefore escape as a gas. To replenish the bath the platinum diamino-nitrite is dissolved in a 5% solution of ammonia by heating, as in preparing the orignal solution, and then added to the bath. Ammonia should also be added to the bath occasionally to replace that lost through evaporation. Although the cathode efficiency of this bath is also poor, it covers quickly and has fair throwing power. A flash plating may be obtained in from thirty to sixty seconds. If a heavier deposit is desired, the metal content of the bath should be increased and the work scratch brushed and plated for eight to ten minutes with a current density of about 55 amperes per square foot and a voltage of 2.4 volts. The brightest deposits will be obtained at a pH of 7 or less. If the pH is allowed to drop below 6.4 peeling may occur.

* U. S. Patent 1,779,436—Baker & Co.

For best operation, the anodes should not be too small and should be maintained at a distance of not more than a few centimeters from the work.

Gold, silver, copper and brass may be plated with platinum directly; iron, steel and other metals should first be plated with either copper or one of the other aforementioned metals. Unless this is done the deposit is likely not to be adherent and in addition the basis metal will cause decomposition of the bath. In all cases, before immersion in the bath, the basis metal should be cleaned by electrocleaning, acid dips, and cyanide.

Palladium

Palladium is a white metal with a lustre almost that of silver and a melting point of 1550° C. Since its specific gravity is only 12.16, about sixty percent that of platinum, an equal weight of palladium will cover almost two-thirds again as much surface as platinum for any given thickness. It is ductile and malleable and about as hard as nickel. Under ordinary conditions it is highly resistant to tarnish and corrosion and is hardly affected by either hydrochloric or sulphuric acid, but is soluble in nitric acid.

Despite the fact that it is not quite so permanent as platinum, its lower price and better covering power have caused it to displace the former in a number of applications and will undoubtedly be important factors in determining its future. Although, like platinum, it has not yet achieved widespread industrial popularity, it has been used for coating the working parts of watches and is being used more and more for reasons of economy as an undercoat for the more expensive rhodium. Its low price and low specific gravity also make it suitable for electroforming. Although in the past some difficulty has been experienced in this connection because the deposition of hydrogen along with the palladium has a tendency to cause warping and deformation of the electroformed article, this objection is said to have been overcome by the modern bath to be described later.

One of the first palladium baths is that of Pilet and has the following composition:

Palladous chloride	0.5 ozs.
Disodium phosphate	13.4 "
Diammonium phosphate	2.6 "
Benzoic acid	6 dwt.
Water to make	1 gal.
Operating temperature	125° F.
Current density	1.8 to 2.8 amps./sq. ft.
Voltage	1 to 2 volts.

The solution is boiled until the color changes from dark red to light yellow, indicating the formation of a complex amino-palladium compound. This bath is satisfactory for short plating periods only. At first the deposit is bright, but quickly grows dull and cloudy. Since platinum or palladium anodes are used it is necessary to replenish the bath periodically with additions of palladous chloride, and then to repeat the boiling operation referred to above. The same disadvantage is inherent in this bath as in the platinum chloride bath, namely the presence of undesirable chlorides.

As in the case of platinum, this disadvantage can be overcome by using the amino-nitrite of palladium instead of the chloride. The life of the bath is thereby increased, since no chlorides are formed, and the cathode efficiency remains high. However, the current density must be held below the gassing point to prevent the deposits from becoming dark and powdery.

The following formula may be used for the amino-nitrite bath:

Palladium amino-nitrite	8 gms.
Ammonium nitrate	100 "
Sodium nitrate	10 "
Water to make	1 liter
Voltage	1.2 to 1.5 volts
Operating temperature	150° F.

When preparing the above solution, the palladium amino-nitrite is first dissolved in a small quantity of ammonia. If a pH of 7 or more is maintained, the deposit grows smoky fairly quickly, but heavier deposits may be obtained by the use of scratch brushing. If a pH of less than 7 is maintained, brighter deposits result, but the danger of peeling increases.

All of these difficulties are said to be overcome by a patented salt* which comes prepared in a concentrated solution containing 40 grams to the liter and is simply diluted with water. The bath which results is alkaline in content. For flash deposits the following proportions are recommended:

Palladium as prepared salt	2 to 3 grams
Water to make	1 liter
Operating temperature	150° F.
Voltage	3 to 4 volts
Current density	20 to 30 amps./sq. ft.
Plating time	30 to 120 secs.

It should be noted that flash deposits may be obtained with concentrations of these salts ranging from as little as 1/48 gram to 13 grams per liter and current densities of 14 to 70 amperes per square foot. For heavier deposits and electroforming, the concentration may be increased to 80 to 100 grams per liter and a current density of 3 to 4 amperes per square foot used.

Palladium may be plated over a flash nickel undercoat or directly on the basis metal, except in the case of zinc, tin and lead alloys. For these metals a heavy nickel undercoat is essential.

Rhodium

Rhodium is found associated with platinum in the proportion of about two to five percent. It is an extremely hard metal with a blue white lustrous color having a specific gravity of 12.44 and a melting point of 1970° C. It is insoluble in nitric acid and aqua regia and is not attacked by sulphur fumes but does dissolve in hot sulphuric acid. It does not tarnish or oxidize at normal temperatures; above 300° C however, it does tend to oxidize and is attacked by chlorine.

* Pallite Salts—Lambros Precious Metals Corp.

Rhodium baths are easy to operate; they are not too critical insofar as current conditions are concerned; and the baths have excellent throwing power, approaching that of the gold or silver bath. Although rhodium is more costly than platinum, it has a much lower specific gravity and therefore an equal weight of rhodium will cover almost two thirds again as much surface as platinum for any given thickness. A silver basis metal coated with rhodium to a thickness of one ten-thousandth of an inch will withstand the action of boiling aqua regia for thirty minutes with no change in either weight or appearance. A coating one one-hundred thousandth of an inch in thickness makes silver untarnishable. Rhodium has about 80% of the reflective power of freshly polished silver to visible light and in the ultra-violet region its reflectivity is greater than that of silver. Small articles can be coated with rhodium in a few seconds, even when they are suspended in bundles. Because of this and the other advantages already enumerated, rhodium can sometimes compete successfully with much lower-priced metals. Rapidly, rhodium is replacing all other metals as the standard finish for white, non-tarnishable surfaces in such applications as reflectors, jewelry and optical goods.

In general, in this country only acid electrolytes have been found to give a brilliant white finish and to possess good throwing power, although a number of patents have been granted covering other types of baths.

There are two acid baths commonly used, employing a commercially prepared rhodium salt, usually in the form of an acid phosphate complex. One of these baths is known as the sulphate type and the other as the phosphate type. The formulas are as follows:

Sulphate type

Sulphuric acid (concentrated)	35 grams
Metallic rhodium as prepared solution	2 "
Water to make	1 liter
Temperature	110 to 120° F.
Current density	10 to 80 amps./sq. ft.
Voltage	2½ to 5 volts

A platinum anode is used and since the anode is insoluble, the bath must be replenished by the addition of rhodium salt. The acid must be added to the water before the rhodium; otherwise the rhodium may be partly precipitated by hydrolysis.

Phosphate type

Phosphoric acid (85%)	10 to 40 cc.
Rhodium metal in prepared form	2 grams
Water to make	1 liter
Operating temperature	110 to 120° F.
Current density	10 to 80 amps./sq. ft.
Voltage	2½ to 5 volts

Here too, the anode is of platinum and the bath must be replenished by the addition of the rhodium salt. Again, as in the sulphate bath, the acid must be added to the water before the rhodium.

In both of the above baths, the cathode current efficiency increases with a decrease in the free acid concentration and also with an increase in the rhodium content and temperature. On the other hand, the cathode current efficiency goes down as the current density goes up.

Because of the highly acid nature of the baths and the harmful effects of metallic impurities, even in small quantities, the plating cells are generally of pyrex, vitreous stoneware, silica, or crockery. For plating very large pieces, lead lined tanks, with the lining acting as the anode, can be used, but with the sulphate bath only.

Impurities may be introduced into the bath either externally or by the action of the bath on unplated surfaces, bus bars and tank linings or insulators. Many basis metals cause no trouble, but a few, like nickel, tin, zinc or copper, as well as organic impurities, may cause the finish to be dull or black. Zinc, even in quantities as small as a few hundredths of a gram per liter will cause trouble. In this connection a patent* has been issued covering a method of removing from the bath not only all of the aforementioned metals, except copper, but mercury, lead, silver and cadmium as well. An excess of potassium ferrocyanide is added to the bath to precipitate the undesired metals without affecting the rhodium content. Since the excess of potassium ferrocyanide interferes with the operation of the bath and may even stop the deposit altogether, it must be removed by adding a soluble ferric salt such as ferric sulphate, preferably in slight excess, which does not affect the operation, after which the electrolyte is filtered.

Before subjecting the work to the rhodium plating bath the cleaning methods ordinarily used on nickel or gold should be applied.

It is common practice to use nickel or bright nickel as an undercoat, except in the case of gold alloys and platinum bases, to prevent the possibility of a dark and streaky finish. The thickness of the pre-plate will be influenced by the basis metal, zinc, tin and lead alloys requiring heavy undercoats to protect them from the action of the electrolyte.

* U. S. Patent 2,401,331. A. Brenner and W. A. Olson, assignors to The United States of America, June 4, 1946.

Bibliography

Electrochemical Society, *Modern Electroplating*, New York, (1942).

J. Rosslyn, *Electro-plating and Anodising*, G. Newnes Ltd., London, (1941).

Plating and Finishing Guidebook, Metal Industry Publishing Co., New York, (1945).

Blum and Hogaboom, *Principles of Electroplating and Electroforming*, McGraw-Hill Book Co., Inc., New York, (1930).

Langbein and Brannt, *Electrodeposition of Metals*, H. C. Baird & Co., Inc., New York, (1924).

K. Schumpelt, *J. Electrodep. Tech. Soc.*, **13**, (1937).

R. H. Atkinson, *J. Electrodep. Tech. Soc.*, **13**, (1937).

Metal Finishing, New York, N. Y., **37**, 131 (1939); **38**, 587 (1940); **38**, 647 (1940); **39**, 16 (1941); **41**, 73 (1943).

Fink and Lambros, *Trans. Electrochem Soc.*, **63**, 181 (1933).

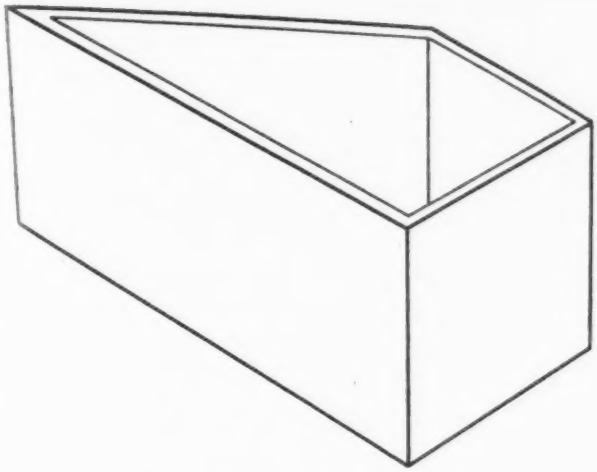


Fig. 1. Hull Cell.

The Hull Cell

• • •

By H. J. SEDUSKY and J. B. MOHLER

Research Chemists, The Cleveland Graphite Bronze Co.

• • •

A PLATING bath will operate successfully only when all sources of trouble are under proper control. This is an obvious fact, but the sources of trouble are not always obvious. Troubles may arise from improper chemical concentrations, drag-in of impurities, contamination from the atmosphere, contamination from the plating racks, products of decomposition of the chemicals in the bath, impurities in the water, or impurities from the anodes and chemicals themselves.

A number of foreign metals may enter the bath from several sources. If these metals are more electronegative than the metal being deposited they will cause trouble after they reach a critical concentration. Undesirable organic material may enter the bath from rack coatings, stop-offs, or by decomposition of addition agents.

There is one method to test for these and other troubles that produce an undesirable appearing plate. The way to do this is to plate a few pieces of work and observe the results. These tests may indicate freedom from trouble but upon plating at another current density or plating an article of an entirely different shape, troubles may appear. Such troubles may be detected by plating a series of test specimens over a range of current densities.

If plating at several current densities reveals a troublesome plating range then it is logical to use a plating test that covers the entire plating range in one operation. The Hull cell was developed specifically to provide such a test. A plate from this test covers the normal plating range plus a higher and lower current density range. It is in this extra range particularily that troubles may be predicted before they appear in the normal plating range.

Let us take an example to show how the plating test reveals troubles:

A bright nickel bath begins to develop a smoky deposit on production pieces. Chemical analyses show that all essential chemicals, including the primary brightener, are within the proper limits. Sufficient anti-pit agent is known to be present by measurement of surface tension.

A plating test is run and the same smoky deposit appears over part of the plating range. From previous experience with prepared standards it is known that this typical test plate indicates an excessive amount of anti-pit agent present. The surface tension measurement did not locate the trouble because the surface tension test does not reveal an excessive amount of anti-pit agent, but only establishes that a sufficient amount is present.

The bath may now either be treated with activated carbon or electrolyzed with dummy cathodes to remove all or part of the surface active material. After treatment and readjustment of the bath a second test may be run to confirm expected bright plating.

The point to this hyopthetical case is that the best way to make an over-all test is by a plating test and the best plating test to use is one that covers the entire plating range required in production.

The Hull test is a universal plating range test. It may be used to predict results for the variation in current density on all but the most complicated shapes. The variation in current density during plating is the greatest of any of the common variables. It does not change at a given point with time but it does vary with the shape of the article being plated. It is low in recesses and high on corners and edges. Temperature, voltage, chemical composition and agitation are not variable for the normal time used to plate one rack but the current density varies at almost every point on every piece. Usually, however, the current density stays within the allowable plating range.

A Hull test may be run and the results show that

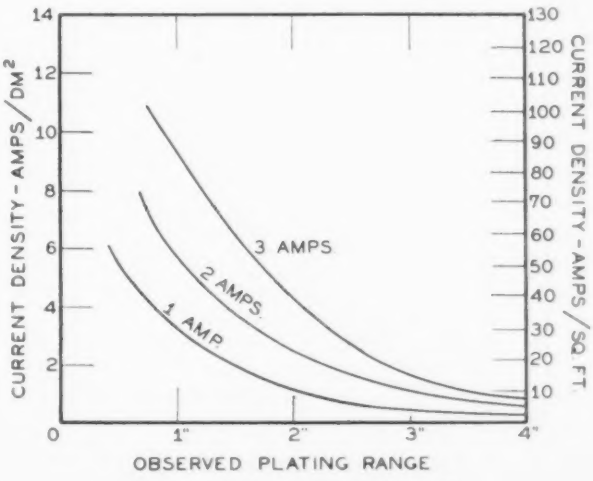


Fig. 2. Plating range of Hull Cell.

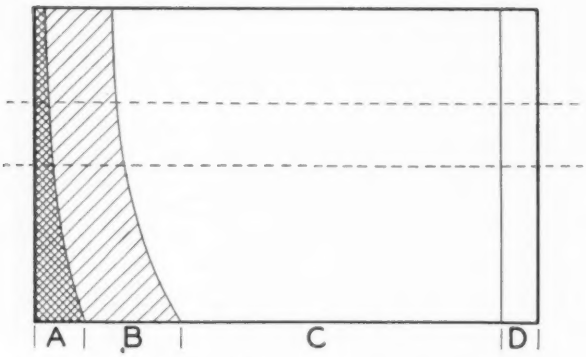


Fig. 3. Typical Hull test plate of a nickel bath.

the width of the plating range available is at an optimum value. At the same time current density troubles may be experienced in the bath (such as burning in high current density areas). An attempt to overcome this trouble may be made by lowering the total current used. The burning may cease but new difficulties may now be encountered by the pieces not covering in low current density areas. The plating test showed that the bath was functioning at its optimum range. However, experience with the bath showed that the range was not wide enough for the pieces being plated. The problem then is one of racking and must be solved by robbing, shadowing or anode arrangement. The plating test was of specific value in that it showed that attempts to change the bath and extend the plating range would be useless.

The Hull cell may be used to measure plating ranges but its greatest value is as an analytical and control instrument. As such, it may be used both to detect present troubles and avoid future difficulties.

It is possible to control a plating bath with nothing more than a Hull cell and a hydrometer. A chromic acid bath is an example of a bath that may be controlled in this manner without chemical analyses. A bath as complicated as the brass bath may also be controlled to a great extent by the Hull test. For most baths however, it is best to run both the plating test and chemical analyses since the latter gives definite, desirable, quantitative information.

The cell used in the Hull test is shown in Figure 1. The cell is so constructed that the current density changes regularly for every point along the width of the cathode.

Fig. 4. Notebook entry of a Hull test plate.

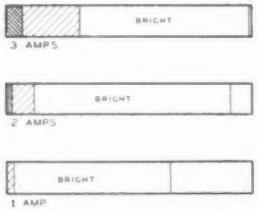


Fig. 5. Effect of total current on plating range.

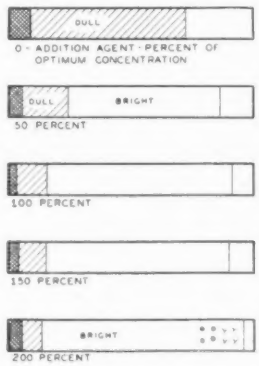


Fig. 6. Effect of addition agent on a nickel bath.

The preferred cell[1] holds 267 milliliters of solution. For this volume, an addition of 2 grams of solid is equivalent to one ounce per gallon. An anode is placed at the square end of the cell so as to cover the entire end. A 2½" x 4" cathode is placed at the opposite inclined end of the cell.

The total current used depends on the type of bath being tested. The current density at any point on the cathode can be obtained by referring to the graph in Figure 2.

The graph of Figure 2 was calculated from the equation:

$$A = C(27.7 - 48.7 \log L)$$

Where A = current density
C = total current
L = distance along cathode

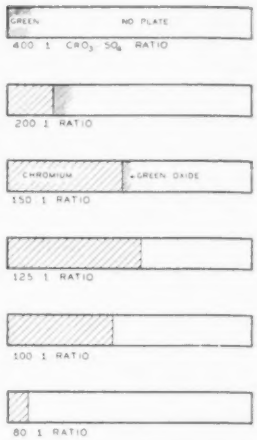


Fig. 7. The effect of sulfuric acid on a chromic acid bath. 5 amps., buffed copper cathode, temp. 35-45° C.

This equation does not hold strictly true for all plating baths but the variation from bath to bath is not large.[2] In any practical case it is advisable to run standard plates for all of the important bath variables

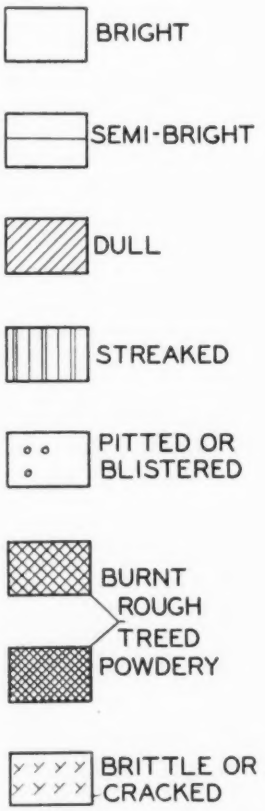


Fig. 8. General code, illustrating the common method of indicating appearance of areas on test plates.

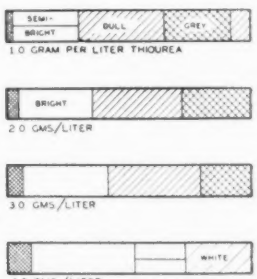


Fig. 9. The effect of an addition agent on an acid silver bath. 1 amp., steel cathode, room temp.

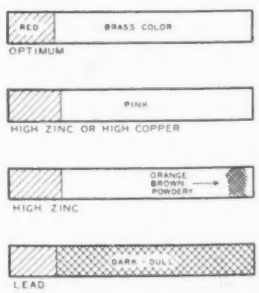


Fig. 10. Brass. 1 amp., steel cathode, room temp.

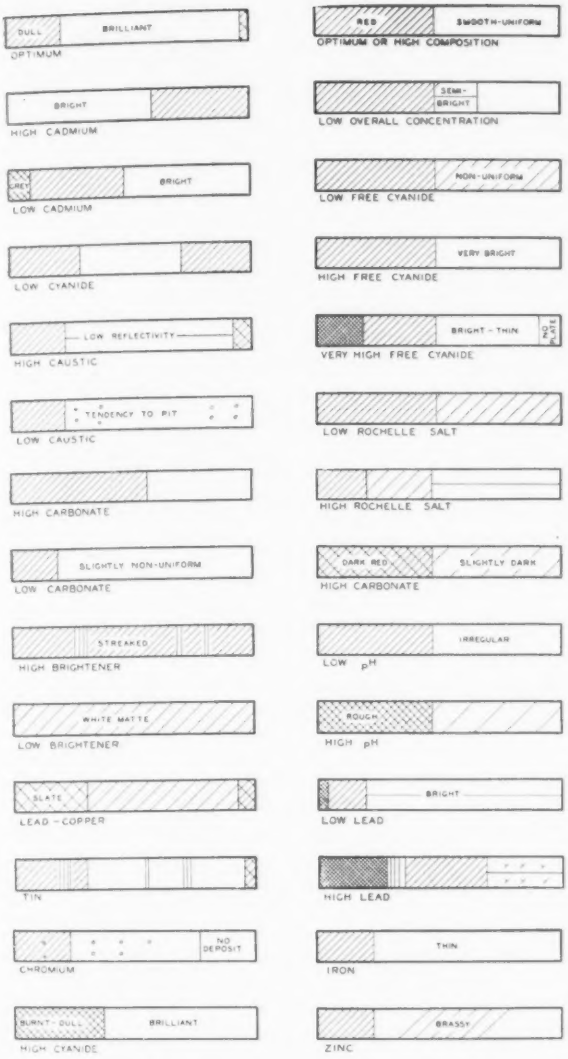


Fig. 11. Bright cadmium. 3 amps., polished steel cathode, room temp.

Fig. 12. Rochelle copper. 2 amps., steel cathode, temp. 50-60° C.

in order to become familiar with the typical appearance of a plate. Preparation of the standards should simulate as closely as possible production operations including cleaning, pickling and striking steps in order to obtain maximum information from the plates. If the bath is agitated in actual practice, as in the case of the high efficiency cyanide copper bath, then mild agitation with a stirring rod should be used during the test.

It is not always best to run the test at the same average operating current density since some other total quantity of current may give greater sensitivity in seeking information on the effect of a definite addative. An example will presently be given to illustrate this point but first let us look at a typical Hull cell plate in Figure 3.

A plate as in Figure 3 might be obtained from a cold nickel bath using a brightener. The high current density end of the plate is at the left. The area A is dark and rough, B is dull, C is bright and at D there is no deposit or it is very thin. The lines from the top to the bottom of the plate marking the zones between A and B and between B and C curve toward the low current density end. This is caused by interruption of the flow of solution along the cathode by the bottom of the cell, but it does not interfere with interpretation of the results. A good scheme for showing typical results is to sketch the appearance of only the part of the plate observed between the dotted lines. A notebook entry would then appear as in Figure 4.

If the purpose of the test is to evaluate the effect of addition agent concentration in a new bath, the total current used should be that which will give the widest possible bright range. For instance, the plates shown in Figure 5 might be obtained for a total current of 1, 2 and 3 amperes.

It is seen that as the total current is increased the

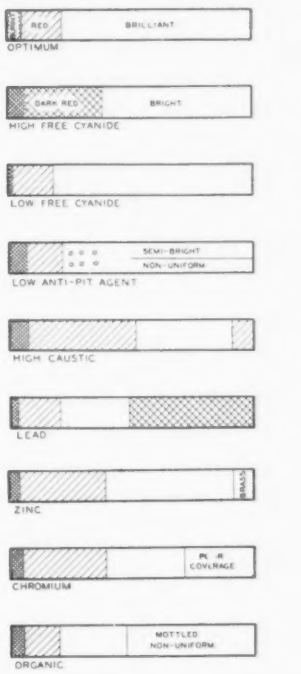


Fig. 13. High efficiency copper. 2 amps., steel cathode, agitate length of cathode 4 inches per second, temp. 75-85° C.

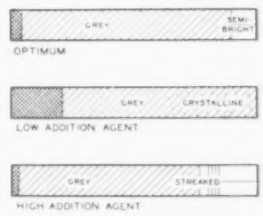


Fig. 14. Acid lead (fluoborate). 3 amps., steel cathode, room temp.

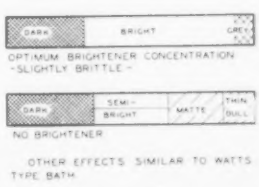


Fig. 15. Barrel nickel. 2 amps., steel cathode, room temp.

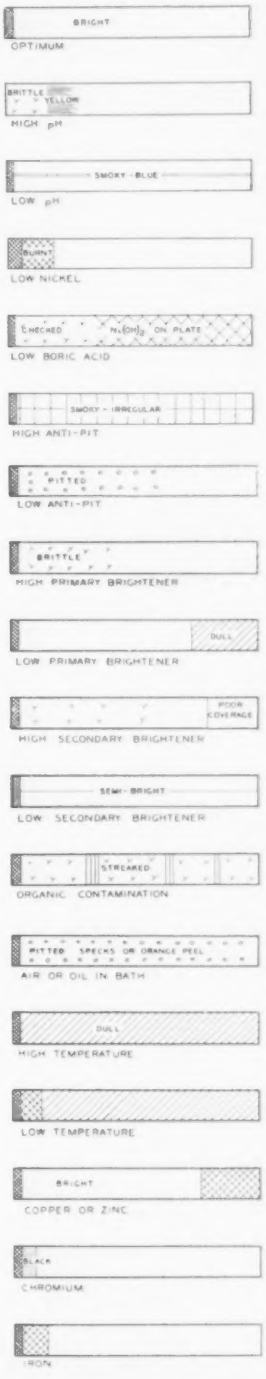


Fig. 16. Bright nickel (Watts type). 3 amps., polished steel cathode, temp 40-45° C.

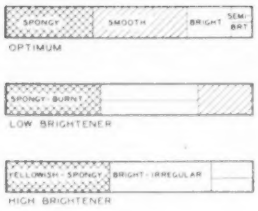


Fig. 17. Cyanide silver. 1 amp., silver struck brass cathode, room temp.

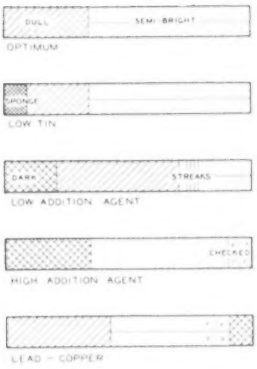


Fig. 18. Acid tin. 2 amps., steel cathode, room temp.

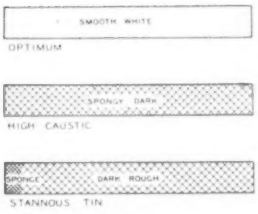


Fig. 19. Alkaline tin. 2 amps., steel cathode, temp. 70-80° C.

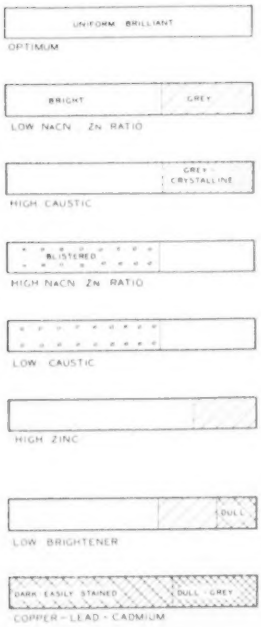


Fig. 20. Bright zinc. 3 amps., polished steel cathode, temp. 40-50° C.

apparent bright range (physical spread) shifts toward the low current density end of the plate. It is also seen that for the cases of Figure 5, that a total current of 2 amperes gives the widest bright range (with respect to proportion of test panel covered).

A series of standards to test addition agent concentration may now be prepared and used for permanent reference.

The Hull cell may likewise be used to estimate the CrO_3-SO_4 ratio in a chromium plating bath.

The above illustrates quantitative application and measurement of covering power. By the use of a hydrometer to maintain proper CrO_3 concentration and by referring plating tests to the above standards, it is possible to control a chromium bath with no further analyses.

After a bath is in proper chemical limits and free of impurities, the Hull cell may next be used to test for the concentration of addition agent present. The following plates for example were obtained on adding increasing amounts of thiourea to a silver fluoborate bath.

It is well to examine typical Hull cell plates obtained from the common plating baths under various conditions.

If the deposit is off color add sodium bicarbonate in increments of 1.0 oz. per gal. An improvement in color indicates that the zinc content of the deposit is too high. This condition can be corrected by one of the following, depending on the condition of the bath:

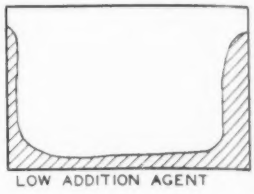
1. Add sodium bicarbonate
2. Add copper cyanide
3. Add sodium cyanide (at high pH)

If the deposit is off color and bicarbonate does not improve the color, add sodium hydroxide in increments of 0.5 oz. per gal. An improvement in color in this case indicates that the copper content of the deposit is too high. This condition can be corrected by one of the following:

1. Add caustic sooda
2. Add zinc cyanide
3. Add both copper and zinc cyanide to lower the free cyanide content.

The Hull cell may be used in many other applications in addition to those for analysis and control of plating baths. The test is invaluable to the experimentalist in developing or evaluating new plating baths. In a single operation a complete story of the behavior of the bath over a wide current density range is obtained. If the plating range is narrow, then additions may be made and any shifting or widening of the range noted. By such a procedure it may be readily observed if the shift is in a favorable direction.

The Hull test may also be used to measure the covering power of a bath.[1] For example, if a total current of 0.2 amperes is used the current density range over the length of the cathode will be from 0.4 to 12 amperes per square foot. A test may be made to reveal the



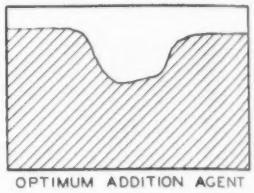
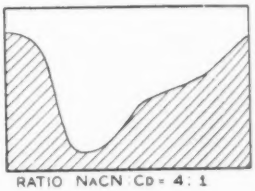
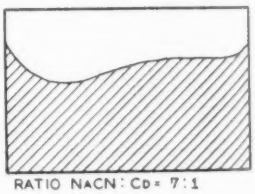


Fig. 21. Back of test plate for an acid lead bath.





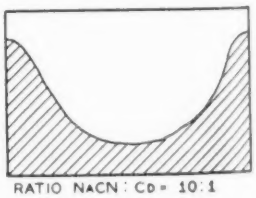


Fig. 22. Back of test plate for a cyanide cadmium bath.

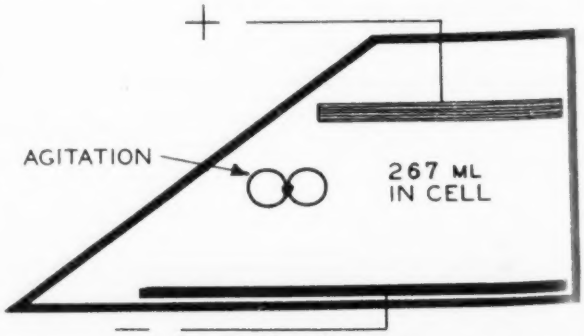


Fig. 23. Electrolysis test.

minimum current density at which plating will take place. A basis metal of contrasting color to the intended deposit will facilitate ease of observing the least covered areas.

In making covering power tests, a standard surface and cleaning procedure must be used. The plating time should be the same for each set of tests. When any condition is changed the tests will vary and will be comparable only within the set.

The fact that standardization is necessary for a covering power test indicates that variables, other than those of the plating bath, may be tested. In fact this is the case. The cleaning procedure [3] may affect the covering power and a low current Hull test may be used to determine the best cleaning procedure.

A low current (covering power) test will readily show the effect of addition agents that improve or impair covering power. In the standard test, advantage may be taken of the fact that the back of the cathode is a low current density area. The effect of addition agents may be observed as in Figure 21, or of variation in bath components in Figure 22.

The effect of impurities will also readily show in this low current density area. With experience on a particular bath the back of the test plate is sometimes as informative as the front.

When Hull tests are conducted it is best to run a number of them. Just like any other analytical tool, if two tests are run and checks are obtained the results obtained are correct. If one test is run, the answer will occasionally be misleading. This can happen with improper cleaning of the cathode, or too great a fluctuation in bath temperature or current density during a test.

If trouble is suspected as result of a test then corrections should be made on a small portion of the bath and a second test should be run. From the process of corrections followed in testing, the exact treatment for a large bath can be determined.

If a large bath shows noble metal contamination it should be electrolyzed at low current density. This may be done in the Hull cell by using a cathode parallel to the anode. Agitation should be used during the treatment. Occasional tests should be run to determine the length of time required to remove the contaminating metal. From the time and current used to remove the metal, the ampere-hours per gallon may be calculated and the time estimated to treat a large bath.

Example:

A nickel bath shows copper contamination. A $2\frac{1}{4}$ x 4 inch cathode is placed on one side of the Hull cell 2 inches deep as shown in Figure 23.

A current of 0.28 ampere (current density 5 amp./sq. ft.) removes the copper in 10 minutes. The original tank is 1000 gallons and the cathode area to be used to electrolyze the copper is 10 square feet.

From the Hull cell data:

$$0.28 \times \frac{10}{60} \times \frac{1000}{267} = 0.175 \text{ ampere-hours per liter.}$$

or:

$$0.28 \times \frac{10}{60} \times \frac{3780}{267} = 0.66 \text{ ampere-hours per gallon.}$$

From the tank data:

$1000 \times 3.78 = 3780$ liters.

$10 \times 5 = 50$ amperes.

$$0.175 \times \frac{3780}{50} = 13.2 \text{ hours at 50 amperes to remove copper.}$$

Acknowledgment

Mr. Frank MacIntyre has examined thousands of Hull test plates.

The authors are indebted to him for his constructive suggestions prior to the drawing of typical plates.

References

1. F. H. MacIntyre and R. O. Hull. Am. Electroplaters' Soc., *Proceedings* (1943).
2. R. O. Hull. Am. Electroplaters' Soc., *Proceedings* (1939).
3. *Trans. Electrochem. Soc.*, Oct. (1945) **88** 338 (1945).

Color Control for Aluminum Dyeing

By E. Rhael and F. P. Summers

Sandoz Chemical Works, Inc., N. Y. C.

CURRENT trends indicate a rapidly increasing interest in colored anodized aluminum. Primary organic dyestuffs have long been recommended for this purpose and we wonder whether or not there has been any great amount of effort expended in the creation of distinctive shades. The tendency seems to be toward standard colors, and different manufacturers appear to duplicate their competitor's color and pattern. A progressive industry demands wide variation of color as well as of design and finish. It is most important that each item should be exquisitely finished with an assortment of tones that will enhance the appearance and stimulate the eye appeal.

Fig. 1. Practicing anodized aluminum dye control with the equipment listed.

These results can be obtained with a better knowledge of blending and routine control. There is nothing complicated or mysterious about this technique although a willingness to follow rudimental procedure is essential. The prerequisites are:

Metal free from structural defects
Uniform polishing or etching
Perfect cleaning before anodizing.

The anodizing conditions must be accurately controlled both as to temperature and time because the depth of shade, and therefore tone, are directly proportionate to the quantity as well as quality of the anodic coating produced.

The anodized material must be thoroughly rinsed to avoid carryover of anodizing solution to the dyebath. Otherwise such substances as chrome salts, aluminum salts, copper salts and free acid may be added to the dyebath, all of which are deleterious to the control of the dyeing process. Should there be a delay between anodizing and dyeing, the work should be stored in a running cold water bath to prevent dye streaks.

Dyeing Technique

Dilute dye bath solutions are recommended for the reason that they may be more frequently replaced and are therefore more economical. A concentration of ⅛ ounce of dye per gallon of water (1 gram per liter) is ample for all shades except black, where a concentration of one ounce per gallon (8 grams per liter) is sufficient. Dye baths should be renewed whenever the dye solution becomes cloudy or loses its fresh appearance.

Normally the temperature of dyeing is not too critical, but it is well to remember that as the temperature rises the sealing of the anodic coating increases. At the boil, for example, the sealing is so rapid that dye absorption is curtailed. In general, the rate of dyeing increases with the temperature. A happy medium should be attained; usual practice is a temperature of 140° F-150° F for ten minutes.

For pastel shades, more dilute solutions are used and the time of dyeing is also shortened. The rack is merely dipped into the dye bath for a few minutes, then quickly rinsed in cold water and examined for shade. The depth of color can be increased if necessary by returning the rack to the dye bath for a further short period.

After dyeing, the work should be rinsed well, sealed, dried and buffed.

Dye Control

Equipment used in simplified dye control:

1. Standard solutions of dyes in process.
2. A stock of test tubes (¾" x 6"). The test tubes should be numbered from 1-20 by marking with red pencil at the top of the tube.
3. Circular metal test tube rack (8" diam.).
4. Rectangular test tube rack (10" x 4") for storing test tubes in process of loading.
5. Enamel kettle (9" x 6") to be used as water bath for circular test tube rack in dyeing operation.
6. Series of graduated cylinders, 25 cc, 50 cc, 100 cc.
7. Two 10 cc pipettes.
8. One red wax marking pencil.
9. One pair stainless steel crucible tongs (9½" long).
10. One dairy thermometer 0°-250° F.
11. One tripod (8½" wide) to support dye bath kettle.
12. One stove or Bunsen burner.

The test should be made on aluminum strips (½" x 4") cut from polished sheets of the various alloys being processed.

The strips are numbered in series from 1 to 20 by printing the number on one end with an ordinary pen

and using a commercial sodium hypochlorite solution (16 Degree Baume) for the writing medium, or by the use of a stylus. The marking should be allowed to dry.

A series of these strips can then be mounted in a standard coil rack. Each morning a rack of strips is cleaned, etched, anodized along with the commercial work and rinsed in cold water. The strips are then removed from the coil rack, placed in a beaker of cold water, and reserved for laboratory testing purposes. Anodized strips should be handled with tongs or finger marks will result and the tests become ineffective.

The tests are conducted as follows:

All test tubes from one to twenty are stored in the rectangular rack. Tube No. 1 is filled with the standard laboratory type of dye to be tested; tube No. 2 is filled with the plant sample being tested. Other solutions to be tested are alternately filled in the same manner.

Meanwhile the dye bath containing the circular rack is filled with water and heated to 150° F. The loaded tubes are transferred to the bath, and using the tongs, the numbered anodized strips are put into the correspondingly numbered test tubes, and the whole heated for ten minutes.

The circular test tube rack is then removed from the kettle and the dye solution washed out from each tube with running cold water, storing the rectangular rack with the metal in the running water. If sealing is unnecessary the pieces can be dried with a soft cloth and compared—standard versus plant sample.

If sealing is required each tube is refilled with the sealing solution, the dyed strips placed in their correspondingly numbered tubes and the whole returned to a bath heated to the desired temperature, then the work is rinsed and dried as above for comparison between the laboratory and the plant bath to determine whether or not the latter is equal to the standard in relation to quality of shade.

To determine plant bath strength strips of filter paper 2″ wide by 6″ long may be used. One piece is dipped into the plant bath and one into the laboratory type and the strips compared as they are draining. It can readily be seen if the plant bath shows any weakness, turbidity or shade change.

The described procedure is simple, economical and requires not more than a half-hour; it is an exact duplication of the plant process in that all but the dyeing operation is plant procedure.

Color Combinations

So far only individual or "self" colors have been discussed. There is available a complete range of reds, yellows, blues and violets, but there is no range of self greens. These must be made from combinations of blues and yellows selected to produce greens of desired light fastness. The admixture of colors requires a knowledge of the compatibility of the components to each other. For Kelly Greens, Aluminum Blue A and Aluminum Yellow A are compatible. This can be confirmed as follows:

Eleven strips, all properly numbered, from plant-cleaned and anodized stock are dyed in test tubes using the circular rack and bath. The results are noted in a laboratory sheet as follows:

(In this space record plant anodizing conditions for the preparation of the strips, dye concentration, temperature and dyeing time.)

Test Tube	*Strip No.*	*Aluminum Blue B*	*Aluminum Yellow A*
1.	Strip 1	100 cc	0 cc
2.	" 2	90 "	10 "
3.	" 3	80 "	20 "
4.	" 4	70 "	30 "
5.	" 5	60 "	40 "
6.	" 6	50 "	50 "
7.	" 7	40 "	60 "
8.	" 8	30 "	70 "
9.	" 9	20 "	80 "
10.	" 10	10 "	90 "
11.	" 11	0 "	100 "

Upon examination of the dyed strips placed in serial order it will be observed that a perfect graduation of shade exists from the sky blue of the Aluminum Blue A to the Canary Yellow of this Aluminum Yellow A, all of which are practical for plant production.

A Mustard Green can be produced by using Aluminum Blue A and Aluminum Orange 2B. In this case the orange has added a red influence, and in fact there is obtained with two colors the effect resulting from three primaries. Three color combinations are impractical due to the difficulties of obtaining three primaries with the same exhaust properties.

While on this subject, the production of browns should be considered. There are only a few "self" browns suitable for dyeing aluminum, therefore a brown must be constructed from primaries. This is done by using an orange (yellow plus red) and a violet (red plus blue). It should be remembered that a very red blue is in fact a violet.

A gradation card prepared from Aluminum Orange 2B and Aluminum Blue 2D will reveal a number of pleasing browns, all of which are suitable for plant operation. Another suggestion in this regard is to produce fancy brass shades with a combination of Aluminum Orange 2B and Aluminum Violet 3D. This field is without limit.

Conclusion

According to the previously outlined plans there are prepared about 20 anodized strips per day. For recording purposes a loose leaf binder with thin cards is useful. The series dyeings can be mounted (a series to a page) using rubber cement as a binder. Also the plant procedure of preparation and anodizing, as well as the laboratory data of dyeing can be recorded on this page. Eleven strips can be used for the preparation of a gradation sheet. In a short time an album containing series of all types of compatible shades suitable for plant adoption will be available for the creation of new styles.

Such a background will provide for each manufacturer a range of colors, unique and distinctive. These tones can be combined with equally attractive matte or high lustrous enamel type finishes and there can be created a line of truly artistic products by scientific methods.

Military Applications of Electroplating in World War II

By William Blum

THE uses of plating on specialized equipment for ordnance, aviation and communications involved in many cases the selection of metal coatings to meet unusual or severe conditions. Even though these particular conditions may not exist in domestic or industrial operations, the experience gained in the war may point the way to significant industrial developments. Details of many of the military uses have not been released, so that only brief references may be made to them at this time.

Chromium

The extensive prewar use of bright chromium, e.g., on automobiles, was almost completely abandoned with the curtailment of civilian products, and very little bright chromium was employed on military supplies. However, the use of "hard chromium" on dies, gages, molds, and many forming and cutting tools increased and contributed directly to the war effort by prolonging the useful life of manufacturing equipment under very drastic service conditions. The use of chromium plating to salvage worn parts also increased. Most of these applications were extensions or modifications of prewar practice.

Chromium plating of large naval guns had been practiced for many years at the Washington Naval Gun Factory, but no detailed studies of the plating and performance of different types of guns had been conducted. During the war extensive researches on the cause and prevention of gun erosion were conducted by Division One of National Defense Research Committee. In this connection studies on chromium-plated gun bores were made by the National Bureau of Standards in cooperation with the Geophysical Laboratory, the Franklin Institute, and the War and Navy Departments. Similar work was conducted by Battelle Institute and also by the Armament Research Department in England. The detailed results of these studies have not been released. They led to the adoption in caliber-50 barrels of chromium plating over nitrided steel or in conjunction with stellite liners.

One significant result of these investigations is a realization of the wide variation in properties of chromium deposits. The ordinary chromium used for both hard and bright coatings, deposited, e.g., at 45° to 55° C and 10 to 30 amp./dm.^{2}, has a hardness of about 900 Brinell. It is brittle and contains cracks that increase in size and number when heated, as a result of its contracting by as much as 1%. This type of chromium may contain over 1% of Cr_2O_3. In contrast, chromium deposited at about 85° C and at 40 to 120 amp./dm.^{2} is relatively soft, i.e., about 450 Brinell, and does not contract or crack appreciably when heated. It contains only about 0.2% of Cr_2O_3. The regular deposits were designated as "high-contraction" and the softer as "low-contraction" chromium. Studies on the applications of these types of chromium to various weapons are being continued at the Bureau of Standards in cooperation with the War and Navy Departments.

The largest war-time development of chromium deposition was the use of "porous chromium" or "oil-absorbent chromium," on cylinders of aircraft and Diesel engines and piston rings. This process depends upon the fact that ordinary hard chromium deposits usually contain fine cracks. If the surface is etched, e.g., anodically, these cracks are enlarged, to produce a surface which retains lubricating oil and thereby reduces wear. As these methods have been fully described in the literature[1] only a brief outline of the process and application will be given.

Two types of porosity may be distinguished, viz.: Type I or "channel" porosity, in which the depressions are connected to form a fine net work of channels; and Type II or "pin-point" porosity, in which the pores are distinct and not connected by channels. The specifications[2] for porous chromium for a particular purpose usually define the final thickness, type of porosity, and the "percent porosity," i.e., the proportion of the surface represented by the pores or channels.

Porous chromium was successfully applied for the salvage of aircraft cylinders, which in many cases had a much longer life than the new unplated cylinders. It was extensively applied to Diesel engine cylinders and to piston rings. It will no doubt have many postwar uses.

Excerpt from a paper presented before the Electrochemical Society, Inc., at Toronto, Oct. 16, 1946.

Nickel

During the early part of the war the greatly increased demand for nickel in steels used for tanks, guns and armor plates prohibited the use of nickel plating not only on civilian goods but also on most military supplies. For example, it was only by great effort that small quantities of nickel were released for plating of steel surgical instruments. Serious but not very successful efforts were made to salvage the nickel present in the then unused nickel plating baths in large plants.

After the close of the war it was disclosed in the public press that two important applications of nickel plating were made for the Manhattan Project, upon which details have not yet been released. The Chrysler Corporation developed and perfected methods of applying thick impervious coatings of nickel on the inside of pipes and other equipment used in the Project. At present nickel-lined steel pipe, with 0.005 to 0.010 in. (0.125 to 0.25 mm.) of nickel, is being sold commercially. The Houdaille-Hersey Corporation is reported to have produced "nickel screens" by electrodeposition, but no details of their manufacture or use have been published. These two examples illustrate the fact that almost every branch of science and industry contributed directly to the studies on nuclear energy.

Copper

While copper was not so relatively scarce as nickel, its use in plating was restricted. Some of its applications rested on the fact that thinner coatings of copper could be applied by plating than otherwise. Much copper-clad steel with fairly thick copper coatings was used for such purposes as bullet jackets. On caliber-45 ammunition, however, the bullet jackets consisted of steel electroplated with about 0.0005 in. (13 microns) of copper.

Another extensive use of copper coatings, usually produced by chemical immersion, was on steel to lubricate it during drawing operations, e.g., in making steel cartridge cases. Copper was plated on certain areas of aluminum radio and radar equipment, to facilitate soldering. Certain applications of copper electroforming proved valuable, such as the production of Pitot tubes and airplane models. Copper plating was extensively used to protect steel surfaces during case-hardening.

Zinc and Cadmium

The scarcity of cadmium during the war led to the substitution of zinc for cadmium wherever feasible. Extensive exposure tests have shown that, under practically all atmospheric conditions, a given thickness of zinc yields at least as much protection against the corrosion of steel as the same thickness of cadmium. Cadmium, however, preserves a better appearance and is less likely than zinc to form bulky white corrosion products. The latter objection to zinc was overcome for many purposes by the application of a supplemental chromate film.

Owing to the scarcity and greater cost of the cadmium, its coatings were usually thinner than those of zinc. For example, Army-Navy Aeronautical Specification *AN-P*-32a (Aug. 1, 1944) required for most purposes 0.0005 in. (13 microns) of zinc, while the corresponding *AN-P*-61 (Aug. 1, 1944) required only 0.0003 in. (7.6 microns) of cadmium. In further efforts to conserve cadmium, its use on aircraft was confined by Conservation Directive 5*B* (Oct. 28, 1943), to bolts, nuts, screws and washers; carburetor and magneto parts; external parts of engines in combat aircraft; parts subjected to 260° C (500° F) or higher; parachute and similar safety hardware; and to electric contacts.

One important application of zinc plating was on steel cartridge cases. Extensive corrosion and firing tests showed that good performance could be secured with steel cases that were either zinc-plated and given a chromate finish, or were coated with a baked phenolic varnish.

Early in the war large quantities of fuse parts were cadmium plated, but subsequently zinc plating was largely substituted. Cadmium plating was preferred to zinc on radio chassis and other parts, though on condensers, as previously reported, cadmium coatings sometimes developed fine "whiskers" that caused short circuits.[3] Many applications of zinc plating arose from the substitution of plain-carbon steel for stainless steel, brass, aluminum and zinc die castings. Zinc-plated steel mess kits were used for a short time, but were objectionable because the zinc is readily attacked by acid foods, to form emetic though not seriously toxic compounds. The coinage of zinc-plated steel pennies for one year saved over 5,000,000 lb. (2,300 metric tons) of copper.

Lead

The relatively greater availability of lead than of zinc resulted in considerable substitution of lead coatings on steel. "Terne plate" (steel coated with a hot-dipped layer of lead containing 10% to 25% tin) had been extensively used for years for roofing, which was generally painted. Scarcity of tin necessitated a reduction in the tin content of terne plate to 2.5%. It was then found that for many purposes lead-plated steel sheet was equally satisfactory, though results recently reported[4] indicate that some tin in the electrodeposits increases their protective value. All of these uses of lead-coated steel depend upon the fact, not fully appreciated in earlier years, that even though lead coatings permit initial corrosion of steel exposed through any pores, they tend to be "self-healing," i.e., to seal the pores and to prevent continued corrosion of the steel.

Tin

Cutting off the supplies of tin from the Orient necessitated drastic conservation of tin for both military and civilian purposes. Before the war, most of the hot-dipped tin plate used in the canning industry carried about 2 lb. of tin per base box, equivalent to about 0.00012 in. (3 microns) of tin. It was not found practicable to reduce this thickness much below 1.25 lb.

per base box (1.9 microns) by the hot-dipping process.

Studies and experience before the war showed that by plating it was possible to produce tin coatings down to 0.5 lb. per base box (0.00003 in.) and thereby to extend the supply of tin that was available. Several large strip-plating plants were installed, in some of which acid baths were used, and in others alkaline stannate solutions. In plating flat sheets or strips, the difference in throwing power of these baths is not significant. One important difference in the two types of bath is that the acid baths require tanks with rubber or other acid-proof coatings, while the alkaline baths can be used in unlined steel tanks.

Even relatively thick hot-dipped tin coatings are notably porous. The thin electrolytic tin coatings were more porous than the ordinary hot-dipped tin though usually less so than an equal thickness of hot-dipped tin. To improve the appearance and solderability of the electrolytic tin and to reduce its porosity somewhat, the electrolytic coatings were melted, either by a flame, hot oil, resistance heating, or induction heating.

Silver

The most extensive use of silver plating was for lining bearings for aircraft engines. The principal new problems to be overcome were to increase the speed and uniformity of deposition and to secure the most perfect adhesion. Ingenious methods of testing the adhesion of the silver coatings were developed, including a high-speed centrifugal test employed by the Pratt & Whitney Co.

These silver bearings were usually coated with a lead-indium alloy, which is resistant to corrosion by the lubricants. A coating of lead was first applied to the finished silver surface, followed by a thin layer of indium, after which the combination was heated to a low temperature to alloy the lead and indium. This application of indium illustrates the fact that rare or unusual metals may find specific uses.

One new, important application of silver plating was on parts of radar equipment. This use depends on the fact that most of the conduction of very high-frequency current is a "skin effect" and that hence the maximum conductivity of the surface layer is desirable. A coating of about 0.0002 in. (5 microns) of silver was generally employed. Silver is the best conducting of the metals, but is subject to tarnish, especially by sulfides. Silver sulfide is a conductor, but not nearly equal to silver. Application of a thin film of palladium over the silver surface to prevent tarnish was proposed but not extensively used. Gold plating was also applied over silver, or as a substitute for silver. Because of the high intrinsic costs of silver and gold, and of the high manufacturing costs of many of the parts, nondestructive methods for measuring the thickness of coating would be very desirable. No such methods have yet been fully developed.

Rhodium

Rhodium plating was applied in several plants to large electroformed search light reflectors made by processes described in 1898 by Sherard Cowper-Cowles, and developed by the Bart Reflector Co. Rhodium has a reflectivity of only about 75% as compared with 95% for clean silver. However, silver readily tarnishes and is softer and more easily scratched than rhodium. Some success was obtained with lacquered silver coatings, which yielded higher initial reflectivity than rhodium.

Most of the war-time plating was applied to steel, partly because of shortages of non-ferrous metals. Efforts were made to substitute plated plastics for the plated brass in buttons and insignia. These appeared to be satisfactory, but were not extensively adopted. Some of the well-known discharge buttons were made of plated plastic.

Some developments were made in alloy deposition. "White brass" deposits, and also white deposits consisting of copper, zinc, and tin were announced. While these were applied successfully to some articles, few large military uses were made of them, partly because of the scarcity of tin.

There was considerable increase in the use of colored coatings on metals, some produced by immersion and some by electrolysis. Among the former were several methods of producing black oxide films on steel in hot nitrate and nitrite baths. These coatings furnished little protection against rust unless they were supplemented by suitable films of oil or wax.

The anodizing of aluminum and electrolytic methods of protecting magnesium alloys represent processes allied to electrodeposition that were very extensively applied, especially on airplane parts.

Conclusions

The foregoing examples, which by no means cover all the military applications of electroplating, illustrate the ability of this industry to adapt its methods and products to meet new and unusual conditions. The interest thereby aroused in plating, by both producers and consumers, augurs still further progress in meeting peace-time requirements.

References

1. H. Van der Horst, *Metal Finishing* (N. Y.), **40**, 69 (1942); T. G. Coyle, *Am. Electroplaters' Soc. Convention Proc.*, p. 20 (1944); R. Pyles, *Am. Electroplaters' Soc. Convention Proc.*, p. 136 (1944); T. C. Jarrett and R. D. Guerke, *Metal Finishing* (N. Y.), **42**, 732 (1944).
2. Bureau of Ships, Navy Department, Ad Interim Specification 43P3 (Nov. 1, 1945); Army Air Force Specification 20031A (Dec. 19, 1944).
3. H. L. Cobb, *Monthly Rev.*, **33**, 28 (1946).
4. A. H. DuRose, *Trans. Electrochem. Soc.*, **89**, Preprint 7 (1946).

SHOP PROBLEMS

PLATING AND FINISHING
POLISHING—BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Immersion Gold Plating

Question: Will you tell me where or in what book you advertise can I find out the process and chemicals or tools used in the application of the so-called "Gold Wash."

H. K.

Answer: Formulas for immersion gold will be found in the "Manual of Electrodeposition of Gold and Silver," obtainable from the Du Pont Company and also in "Principles of Electroplating & Electroforming," by Blum and Hogaboom.

A good simple solution is the following:

41% potassium gold cyanide	½ oz./gal.
Potassium cyanide	5 " "
Potassium carbonate	6 " "

Boil before using and operate at 180°F.

Brass Plating

Question: I am having trouble with brass plating spotting out after the work has stood for a little while, even after it has been lacquered. Is there anything that I can do to prevent this? My brass solution has a pink color. Is that an indication that there is some unnecessary chemical in the solution? What should be the pH of a brass solution? I use a quinhydrone meter.

Is there any way to nickel plate aluminum so that it would stand out in the weather, if so, what is the formula?

F. J. N.

Answer: Spotting out is a common complaint, especially in warm, damp weather. Materials which will minimize this condition are obtainable from any reliable plating supply house. The pH of a brass solution cannot be tested with a quinhydrone meter since this instrument is not suitable for pHs on the alkaline side. A special glass electrode meter suitable for high pH solutions or high pH colorimetric sets should be employed. For a clean brass color, the pH should be approximately eleven.

Nickel deposits can be applied to aluminum but they are not recommended for extreme outdoor exposure.

Electroplating School

Question: Can you recommend a reputable school in the New York City area where the fundamentals of electroplating are taught? Your advice on ways and means of acquiring a good grounding in this subject will be highly appreciated.

G. R.

Answer: Courses are being presented at the College of the City of New York, 139th St. and Convent Ave., and at the Institute of Electrochemistry and Metallurgy, 59 East 4th St., New York, N. Y.

Plating Baby Shoes

Question: The writer would like to obtain some information and references regarding the bath, methods, technique involved in electro-plating coatings on babies' shoes and miscellaneous leather articles as such.

J. H. L. P.

Answer: A section on this subject appears in the 1946 edition of the *Plating and Finishing Guidebook* which was published in November. Detailed information on this subject appears in "Metallizing Non-Conductors," by Samuel Wein, copies of which are available at $2 a copy from this office.

Silver Plating

Question: We do silver plating on some of our jewelry; and after putting the items through our regular procedure, we find that we cannot eliminate the powdery substance in the hollows of the ornaments. After silver plating, we wet tumble the ornaments in a tumbler containing various sizes and shapes of steel burnishing balls, together with powdered soap, burnishing aid and water. Is there anything you can suggest that would eliminate this powdered appearance on the finished product?

We are submitting a sample (which has been lacquered) for your examination.

J. M. H.

Answer: We suggest using a silver brightener in the plating solution. Ammonium thiosulfate is very suitable for this purpose and may be obtained from any reliable chemical supply house.

Gold Plating

Question: We have been experiencing difficulty in plating gold, both pink and yellow on brass. The plating does not seem to stand up—the pink gold tarnishes—the yellow gold at times seems to wear off much too fast.

We would like to know if there is a test for durability of plating and if so can you please give us the data for it.

J. B.

Answer: Tarnishing of pink gold deposits is very common in the jewelry industry since, without close control of the solution composition, there is a tendency for the gold content to decrease, resulting in a deposit high in copper. Since the high copper deposit looks like pink gold, the color cannot be used as an indication of tarnish resistance.

Gold deposits are very soft since they are practically pure gold. For durability it will be necessary to lacquer after gold plating. A quick test for quality of the deposit is a drop of solution containing equal parts by volume of nitric acid and water. Note

the time required for gassing to commence, indicating attack of the underlying metal.

Bright Aluminum

Question: The article we have developed is a salt shaker of very fine artistic design. It is desired to make them on an automatic screw machine of aluminum but, unless aluminum is surface protected, it will not stay bright with salt or washing in soap.

We prefer not to plate, but simply buff the finish. Is there an available aluminum alloy or is there a surface treatment other than plating by which we can assure a permanent bright finish?

L. D. P.

Answer: Anodizing is a satisfactory finish for aluminum. If the salt becomes damp, however, the film will be attacked on the inside of the shaker unless protected by a coat of lacquer.

Gold Anti-Tarnish

Question: I am indeed interested in securing information regarding an anti-tarnish dip that is used after gold plating novelty jewelry.

J. M.

Answer: A common procedure is to treat the plated articles with direct current at 6 volts and room temperature in a solution of 1 lb./gal. of chromic acid or sodium dichromate.

Pickling Various Metals

Question: In the past few weeks we have had several inquiries regarding acid pickling of various types of metals. During the war we have done this type of work, but our experience and knowledge was limited to stainless steel (18-8).

I would appreciate receiving any information that you have on pickling copper alloys, also information on etching various types of aluminum alloys.

B. V. S.

Answer: A section on pickling appears in the 1946 edition of the *Plating & Finishing Guidebook*, copies of which are obtainable from this office at $1 a copy.

We suggest that you write the Aluminum Company of America, Pittsburgh 19, Pennsylvania, asking for their booklet "Finishes for Aluminum." This booklet contains information on etching aluminum alloys.

Pewter Plating

Question: I have not had sufficient experience in refinishing old flatware like pewter platters, sugars, creamers. In silver plating mentioned articles, they plate with dark, blackish spots, while items of copper or brass ware plate white, except items as a copper platter, and pewter border edge plating dark, black, uneven; voltage about 1½. Items are silver struck first in separate solution. Can pewter or Brittania ware be plated successfully from the rouge buff or is it important and necessary to be pumice scratch-brushed and water scratch-brushed, dull, for good results?

C. B.

Answer: Evidently the pewter and Brittania ware has a spotty condition of oxides on the surface which are not removed by your scratch brush method. Oxides of such nature can be dissolved by dipping the work in a solution of concentrated muriatic acid, rinsing thoroughly, then pumice and water scratch brushing. By no means should the work be plated, without cleaning, directly from the rouge buff.

Grill Brightening

Question: We are brass plating small steel grills, of approximately 1" mesh and believe it is called expanded metal since the wires are not round but rough and unfinished. They are to be plated in yellow brass and lacquered and the brightest possible finish is desired.

There is no possible way for polishing these mechanically and we would like to know whether you can suggest an acid dip or pickle or way to brighten these grills electrically before brass plating, inexpensively.

J. W. M.

Answer: We do not believe that electropolishing will be satisfactory on these grills but a good finish will be obtained if a heavy copper deposit is applied and bright dipped. A thin brass plate on the bright dipped surface will be bright and ready for lacquering.

Another procedure is to apply a heavy brass deposit and bright dip that. Since the rate of deposition of brass is low compared to that of copper, the first process is advisable.

(*Continued on page* 93)

THIS IS WASHINGTON—

By George W. Grupp
METAL FINISHING's Washington Correspondent

We Stand Upon a Threshold It does not require one to examine tea leaves in a cup to see that the United States stands upon the threshold of a new period of her history. Perhaps without realizing it the Government transferred some of its sovereign power to labor when it passed the Norris-LaGuardia Act. As a result labor demagogues use extravagant language and empty thoughts to confuse their followers and others.

For example, the CIO convention passed a resolution which in part reads: "American democracy cannot tolerate any attempt to impose economic slavery through vicious anti-labor injunctions." And William Green of the AFL voiced these words when John L. Lewis was cited for contempt of court: "all American labor unites with the mine workers in condemning this reversion to the archaic philosophy of government injunctions (with its enslaving and incriminating effects) and this perversion of the Norris-LaGuardia Act."

The epidemic of labor disputes which has swept over the United States during the past year has caused some to ask if private enterprise can continue to exist under the laws, regulations and court decisions of the past decade which emboldened some labor leaders to attempt to make management impotent, to disregard the welfare of the general public, and to defy the Government. Others are of the opinion that we are reaping the harvest of the seeds sown to foster communism, to stimulate revolution, and to encourage anarchy.

Over 100 years ago Lord Macaulay made this prediction about the United States: "Your republic will be pillaged and ravaged in the twentieth century just as the Roman Empire was by the barbarians of the 5th century, with this difference, that the devastators of the Roman Empire, the Huns and barbarians came from abroad, while your barbarians will be the people of your own country and the product of your own institutions."

Daniel Webster must have been aware of these barbarians for in a speech in the United States Senate on March 12, 1838 he said: "There are persons who constantly clamor. They complain of oppression, speculation and pernicious influence of accumulated wealth. They cry out loudly against banks and corporations, and all means by which small capitalists become united in order to produce important and beneficial results. They carry on mad hostility against all established institutions. They would choke the fountain and dry all streams. In a country of unbounded liberty they clamor against oppression. In a country where property is more evenly divided than anywhere else they rend the air shouting agrarian doctrines. In a country where wages of labor are high beyond parallel, they would teach the laborer he is but an oppressed slave. What can such men want? What do they mean? They want nothing but to enjoy the fruits of other men's labor. They can mean nothing but disturbance and disorder, the diffusion of corrupt principles and the destruction of the moral sentiments and moral principles of society."

No one should be deceived when John L. Lewis ordered the miners to return to work for it is merely a temporary truce to enable him to rally his forces. It is only one of a series of shrewd moves which the union leaders will make during the next four months in their stubborn, grim attempt to resist a revision of the Norris-LaGuardia and Wagner Labor Relation acts, and the enactment of legislation which will curb the present power of labor.

Unions are necessary institutions and should not be destroyed, but when their leaders ruthlessly disregard the welfare of the general public and defy the Government then Americans had better stop dreaming about how many angels can stand on the point of a needle. It is time they awake from their sleep of indifference, arise from their couches of apathy, and gird themselves to give battle for the preservation of their freedom. If they bestir themselves too late they will find that the thieves of liberty will give them a kind of security which will make them bow down to a few craft leaders. It will then be too late to consider security without liberty. The negro slaves had security; but, they did not have liberty.

If liberty is not to be lost in this country then both labor and management must (a) value highly the Constitution of the United States, (b) obey the laws, (c) respect the rights of others, (d) help to preserve the welfare and prestige of the country, (e) curb reckless and irresponsible leaders, (f) prohibit the creation of commercial, industrial and labor monopolies, (g) preserve free enterprise, (h) continue private ownership of natural resources and the tools of production, (i) continue a voluntary economic society free from directives, orders and regimentation, (j) preserve the freedom of an individual to be an employee or an employer, (k) curb the organizing of powerful groups who will defy the Government and inflict discomfort and economic losses to others to gain their

own ends, (l) preserve equal opportunity to work, to invest, to buy, to save as one chooses when such choice does not endanger the life and welfare of others, (m) abide by the terms of contracts, and (n) give labor and management an equal right to collective bargaining.

Under the Wagner Act employees are not required to bargain with employers; but, employers must bargain with employees. The Act does not define the term "collective bargaining." One might ask: was this omitted to aid in the destruction of independent and company unions and to gain for other unions monopolistic powers?

Under the protection of the Wagner Act some unions use one of two vicious techniques. First they may call a strike without making known the specific demands, as John L. Lewis did in the recent soft coal strike. Or, they may enumerate many detailed demands which are so onerous and costly that strikes cannot be avoided.

Further examination of the labor question causes one to ask: why should men be denied the right to work if they do not belong to a union? Why should men be forced to pay for the right to work if they do not see fit to join a union? Why should employers be denied the right to hire whom they please, including non-union workers? Are not such restraints an infringement upon human liberty?

It does not require a brilliant mind to see that the unions will use every available method to prevent the outlawing of the closed shop for they are aware of the handwriting on the wall when the voters in the states of Arizona, Nebraska and South Dakota approved anti-closed shop laws. They are alert that in the state of North Carolina a group of veterans have organized the American Confederation of Enlisted Men who have pledged themselves to "fight the closed shop." And they certainly know that plans are afoot to create a national open shop trade union which contemplates calling itself the "Federated Workers of America."

And since employers do not feel that they should be required to bargain collectively with supervisory employees, the United States Supreme Court has decided to review the Packard Motor Car Company case in which this firm questions the right of its foremen to join unions because it feels that they cannot be considered "employees" under the Wagner Act since the law provides that an "employer" is "any person acting in the interest of any employer directly or indirectly." The Packard Motor Car Company is still further of the opinion that the ruling of the National Labor Relations Board and the decisions of the lower courts "will throw foremen into the union stream with the very men they supervise and subject them to union pressure." Management will never know whether the decisions of a foreman was "dictated by union leanings or pressure or in the interests of management."

Naturally the mood of Congress will be affected by the decisions of the Supreme Court in the Packard case and the Lewis case. They will also be influenced by the President's message on a labor program and his desire for preventive rather than "punitive" legislation. What sort legislation will be passed cannot be foretold. But it is certain that some legislation will be passed before March 31, 1947 to prevent a recurrence of the Lewis threat. And in preparing this legislation thought will be given to (1) ways and means of restricting strikes and curbing the powers of labor leaders, (2) the advantages and disadvantages of a 60 day cooling off period, (3) the equalization of responsibilities and obligations of both labor and management, (4) the establishment of a system of Federal labor courts to replace the National Labor Relations Board, (5) the restriction of jurisdictional strikes and mass picketing, (6) the making of unions subject to anti-trust laws, (7) the outlawing of closed shops, (8) the revision of the Norris-LaGuardia and Wagner acts, (9) the rights of supervisory employees, and (10) the rights of employers to sue unions for breach of contracts.

Sulphuric Acid Plant For Sale The War Assets Administration recently offered for sale a complete sulphuric acid concentrating plant located in Copperhill, Tennessee. The plant was designed for a daily production of 286 tons of 93 per cent sulphuric acid from 78% sulphuric acid using 2,420 gallons of fuel oil with a rating of 133,000 BTU per gallon and approximately 200 gallons of cooling water per minute.

Labor Shifting Its Approach in Collective Bargaining Following the Republican Congressional victory the American Federation of Labor announced that the "duties and responsibilities" of management in collective bargaining would be respected. It added that it recognizes "the difference between the functions of management and labor"; and then it pointed out that "management can perform its functions better if it has the benefit of labor's intelligent cooperation." In other words, while higher wages are still deemed necessary, the American Federation of Labor aims to aid management. This means that there will be a shift in approach to future labor bargaining.

Credit and Business In an article on "Will Credit Sales Help My Business?" by Rees D. Stith in the November issue of *Domestic Commerce*, the author discusses the advantages and disadvantages of extending credit and how to establish a sound credit system. In this informative article he makes this interesting observation: "If credit in a limited amount is granted and the customers pay their bills promptly, this arrangement can increase sales to steady, satisfied customers. But if customers are allowed to charge amounts beyond their ability to pay promptly it is drain on the seller's capital and may result in bad-debt losses."

Additional Information on Metallized Paper Released The Office of Technical Services of the Department of Commerce has revealed that the 58 page report PB-39361 which deals with "Metallized Paper Capacitors" is illustrated with diagrams and photographs. This report has additional detailed information on the German process for manufacturing metallized paper capacitors which are said to be better, cheaper and smaller than the conventional foil-and-paper types now used in electronic equipment. In this process a very thin film of zinc is applied in vapor form directly onto the paper dielectric. The report includes 16 pages of specifications for varnish, paint, wax paraffin, vaseline and other condenser materials used.

Gold-Plated Copper Sheets Now Subject to Duty in Uruguay The Government of Uruguay recently announced that platinum veneer sheets on 18-karat gold in proportion of 10 and 20 per cent, from 5 to 12 millimeters thick and from 5 to 12 millimeters wide, to be used in the manufacture of jewelry, and gold

plated copper sheets of from 5 to 12 centimeters wide, 5 to 12 millimeters thick, and containing 5 to 30 per cent gold, to be used in the manufacture of jewelry, have been included in the raw material section of the Uruguayan customs tariffs.

Handbook on Rust-Resistant Coatings Released The Office of Technical Services of the Department of Commerce has just issued a 113 page handbook, (PB-32864: price $3.00), illustrated with photographs and tables on the application of rust-resistant coatings to iron and steel by immersion in an acid phosphate bath. Successful applications of these rust-resistant coatings are said to depend upon an accurate control of the phosphating solution, through proper cleaning and preparation of the metal surfaces, and the properly designed equipment. The handbook describes two types of coatings. One type is designed for high corrosion resistance; and the other produces a surface more resistant to the effects of heat, pressure and abrasion. This handbook was written by Lloyd O. Gilbert, Rock Island Arsenal Laboratory, United States Army Ordnance Department.

Chemical Production in October The Commerce Department's Census Bureau reports that during the month of October, 1946 there was produced in the United States a total of 80,829 short tons of synthetic anhydrous ammonia; 85,554 short tons of ammonium nitrate; 23,152,000 pounds of synthetic ammonium sulfate; 108,171 short tons of chlorine; 32,394 short tons of hydrochloric acid; 3,807,000 pounds of anhydrous and technical hydrofluoric acid; 221,000 gallons of methanol; 61,686 short tons of nitric acid; about 161,000 short tons of phosphoric acid; about 727,000 short tons of soda ash; about 208,000 short tons of caustic soda; about 20,000 short tons of sodium phosphate; 10,422 short tons of anhydrous sodium sulfate; 15,316 short tons of Glauber's salts; and about 2,229,000 short tons of sulfuric acid.

U. S. Discontinues Buying Foreign Copper The Civilian Production Administration announced on November 20, 1946 that the Reconstruction Finance Corporation's Office of Metals Reserve has been instructed to discontinue the purchase of foreign copper, except to fill commitments already made. This means that private importers will now be required to bear the 4 cents per pound tariff. The present Government stockpile of copper is said to be about 160,000 tons as of November first.

Report on German Platinum Industry Issued The Department of Commerce's Office of Technical Service has released a report, (PB-40294; price $5.00) on "The Platinum Metals Industry in Germany." This 71 page report, illustrated with photographs of plants and equipment, describes the important German developments in the processing of platinum and other precious metals. Among other things it describes the German efforts on platinum-gold alloys; the progress in macro-quantitative spectrographic analysis of binary platinum alloys, and the commerciai production of highly reflecting rhodium mirrors.

There Will Be a Shortage of Lead in 1947 The Lead Industry Association of the United States predicts that there will be a deficiency of 200,000 tons of lead in U. S. production in 1947. The Association estimates that the lead demand of the United States in 1947 will be about 1,055,000 tons. Out of this total demand American sources will be only able to supply about 800,000 tons.

Nickel Oxide Sinter Is Name of New Product The International Nickel Company, which recently increased its price on nickel to 35 cents, has developed a new product known as nickel oxide sinter, to be used in the manufacture of alloy steel and stainless steels. Nickel oxide sinter is an economical substitute for electrolytic nickel.

Russian Platinum Said To Be Offered to U. S. Buyers Reports have reached this country that substantial amounts of platinum from Russia may soon be available to United States users. This is expected to ease the price of this metal.

Copper Situation The current critical copper situation is partly due to the five months strike that ended in June, 1946. In spite of the resumption of domestic copper operations it will be necessary for some time in the future to compete in the world-wide market for the available foreign supply and to depend upon the Government stockpile.

German Phosphoric Acid Processes Described The Office of Technical Services of the Department of Commerce has just released a report on "Phosphoric Acid and Sodium Phosphates in Germany," (report PB-34006: price $3.00); and a report on "The German Phosphorous Industry at Bitterfeld and Piesteritz," (PB-34740: price $5.00). The first report deals with the techniques for calcining North African phosphate rock, for neutralizing sodium phosphate with soda ash and for the manufacture of a wide variety of phosphates from sodium phosphate. The second report covers the production of yellow phosphorus from phosphate rock, its conversion into red phosphorus, and the manufacture of phosphorus sesquisulfide, phosphorus chlorides, and phosphoric acid by the combustion process.

Better Zinc Expected to Result from Increased Price The recent increased price of high grade zinc is said by some to increase the production of 4-9 grade zinc by refineries who are in a position to improve the quality of their metal.

Government Terminates Its Buying of Foreign Lead The Civilian Production Administration terminated the Government purchase of foreign lead on November 11, 1946. All private imported lead will be subject to a tariff of 1 1/16 cents per pound.

Copper Prices May Rise The decontrol of copper prices is said by certain experts to have failed to be a panacea for the copper shortage in the United States. In fact they are of the opinion that because of the world-wide increasing demand for copper and reduced stockpiles, the price of copper will be forced upward.

New Soda Ash Plant to Be Built at Trona The American Potash & Chemical Corporation plans to build a $4,500,000 plant which will have annual production capacity of 30,000 tons of refined borax and 60,000 tons of soda ash. The new plant is to be located at Trona, California.

Lead Import Restrictions Removed The Civilian Production Administration removed all restrictions on the importation of lead on November 18, 1946. This was accomplished by amending General Import Order M-63.

Small Business Men Want Simple Tax Form The new Congress will be asked to simplify the federal income tax forms for small business, because the present forms are too complicated for the average small business man.

Direction Issued on Lead Chemicals Direction No. 1 to Limitation Order L-354 was issued by the Civilian Production Administration for purpose of providing that "any producers of lead chemicals who, during the month of December, 1946, is able to obtain and use secondary lead in excess of his quota under Order L-354 for the production of lead chemicals may apply by letter for an increase in his quota to the Civilian Production Administration, Chemical Division."

Patents

Copper Plating

U. S. Pat. 2,410,844. F. K. Signaigo and W. J. Peppel, assignors to E. I. duPont de Nemours & Co., Nov. 12, 1946. A process for plating copper onto a ferrous metal surface which comprises contacting said surface with a heated aqueous solution containing a soluble copper salt of a poly-hydroxythiol, and an acid selected from the group consisting of sulfuric, hydrochloric and phosphoric acids.

Color Applicator

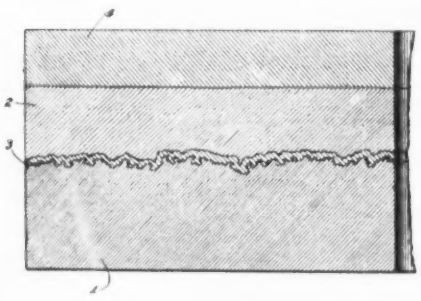
U. S. Pat. 2,411,269. E. Hardesty, assignor to Fuller Label & Box Co., Nov. 19, 1946. A device for applying ceramic color to a surface prepared with an adhesive coating comprising a support for an object having such prepared surface, an applicator adapted to be engaged with ceramic color applied to said coating, means for bringing said applicator and applied ceramic color in contact, means for restraining the support against vibration, and means for vibrating the applicator in all directions.

Tool Plating and Treating

U. S. Pat. 2,411,327. A. E. Lundbye, assignor to Crowell-Collier Publishing Co., Nov. 19, 1946. A method of planting and treating steel metal-cutting tools comprising at least partially immersing a steel tool formed of tool steel in an electroplating bath containing chromium trioxide and sulphate, electrodepositing chromium on said tool at a current density between about 0.7 and 3.5 amperes per square inch for a period of about 1 to 2 minutes to produce a chromium plate not exceeding 0.0001 inch in thickness, making the tool an anode in said bath for a few seconds, removing the tool from the bath, heating it in hot oil and cooling the tool.

Roughening Steel

U. S. Pat. 2,411,532. C. A. Escoffery, assignor to Federal Telephone and Radio Corp., Nov. 26, 1946. The method comprising roughening a surface of a low carbon steel having a carbon content no greater than 0.5% with a mixture of concentrated sulphuric acid and an aqueous solution of nitric acid, the normality of said solution being between about 0.5 and 6 and the quantity by volume of said concentrated sulphuric acid based on the volume of said solution being no greater than 0.2%.



Corrosion Protection

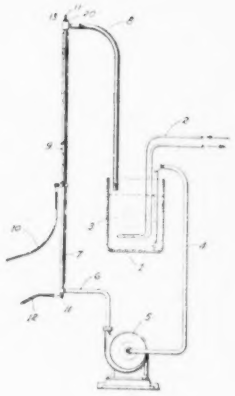
U. S. Pat. 2,411,593. W. G. Routson, assignor to Shell Development Co., Nov. 26, 1946. A corrosion-preventive composition comprising a predominant amount of a hydrocarbon fraction containing finely dispersed a corrosion retardant amount of an organic monobasic acid of between about 10 and about 60 carbon atoms and containing a radical selected from the group consisting of nitrile, nitro, and nitroso radicals which is not more than four carbon atoms removed from the acid radical. A corrosion-preventive composition comprising a predominant amount of a substantially neutral vehicle containing finely dispersed therein a corrosion retarding amount of an organic monobasic acid having between about 10 and about 60 carbons atoms and containing a radical selected from the group consisting of nitrile, nitro and nitroso radicals which is not more than 4 carbon atoms removed from the acid radical, and a small amount of dicarboxylic acid containing at least 16 carbon atoms.

Electrolytic Polishing

U. S. Pat. 2,412,058. L. B. Pfeil, assignor to The International Nickel Co., Inc., Dec. 3, 1946. A process for removing about 0.001 to 0.005 inch of excess metal to dimensionally reduce to predetermined size and electropolish an oversize metal article characterized by intercrystalline oxidation at the surface thereof and made of composition from the group consisting of nickel, nickel-base alloys containing copper, nickel-base alloys containing chromium and stainless steels containing nickel and chromium, which comprises anodically polishing said article in an electrolyte comprising essentially phosphoric acid, sulfuric acid and water, the combined concentration of said acids being at least about 50% by weight of said electrolyte, until about one-third of said excess metal is removed, abrading the anodically polished surface by impact of abrasive particles on said surface to decrease the anodic activity of said surface In a succeeding anodic polishing treatment, repeating the said anodic polishing and abrasion treatments, and subjecting said article to a final anodic polishing treatment whereby by said successive in-order step series of anodic polishing treatment and abrasion treatment and said final anodic polishing treatment said article is reduced to desired dimensions and electropolished.

Electropolishing Stainless Steel Tubes

U. S. Pat. 2,412,186. I. Whitehouse and V. S. Chambers, assignors to Republic Steel Corp., Dec. 3, 1946. The method of polishing which includes the steps of passing thru the annular space between an elongated stainless steel tube and a cathode disposed



axially therewithin a polishing electroly
which fills said space and flows at a ra
sufficient to dislodge gases from the inn
surface of the tube and passing thru th
flowing electrolyte and between the tub
and cathode a polishing current which
of substantially uniform density on eve
unit area of the inner surface of the tube.

Cleaning and Polishing Composition

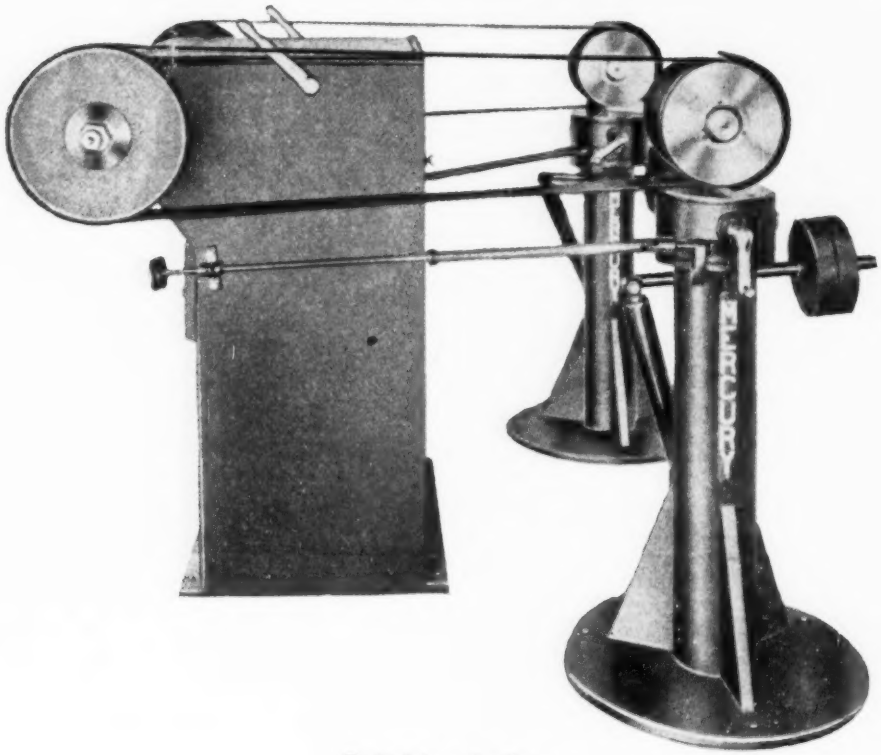
U. S. Pat. 2,411,938. J. Ratner, Dec.
1946. A cleaning and polishing composit
suitable for automobiles and furniture, ca
able of producing a very thin transpare
lustrous preservative film reducible by r
peated applications with a cloth and th
non-accumulative to a thick layer, said co
position comprising from ½ to 5% of a
oil-soluble phenol formaldehyde resin a
from 1 to 8% of a petroleum soluble meta
lic salt of a carboxylic acid as film formi
components, the film forming components b
ing present in limited proportions sufficie
to form a very thin delicate transparent fi
insufficient of itself to act as a protecti
film, the remainder of the composition bei
petroleum hydrocarbons boiling in the ran
of Stoddard solvent, and up to 25% of
compatible organic volatile liquid solve
for the resin and salt.

Vacuum Coating Deposition Apparatus

U. S. Pat. 2,411,715. G. L. Dimmick, a
signor to Radio Corp. of America, Nov. 2
1946. In a vacuum evaporating device f
producing thin films on the surface of a
object, in combination, a holder for su
object, three elongated evaporating elemen
equidistant from and in opposed relation
said holder and arranged symmetrical
along the sides of an equilateral triangle,
foraminous screen in the form of an equ
lateral triangle placed between the evapora
ing elements and said holder for procuri
uniform thickness of the evaporated ma
rial over the whole surface of said obje
said evaporating elements being at an ang
to the sides of said screen, the position a
size of said screen being so selected th
said evaporating elements are just cover
by said screen when viewed from the cent
of said holder on the common axis of s
holder, screen and evaporator assembly.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL FINISHING INDUSTRIES



Polishing Lathes

Manufacturers of a completely new line of polishing lathes and backstand idlers, the Mercury Metal Products Co., a newly organized west coast firm, announce the availability of their equipment.

Base of the lathe is fabricated of 3/4" steel plate. This heavy design, it is claimed, enables smooth operation at high speeds. The motor is mounted inside the base, which is provided with ventilating openings to prevent overheating, and oversize dust-proof bearings and extra heavy shaft are said to give maximum efficiency. A magnetic starter is synchronized with the spindle brake; when "off" button is pressed, spindle is designed to stop and remain braked so that wheels can be changed without loss of time. The lathe itself is of generous overhang construction, and together with extra long spindle, is said to be especially adaptable for heavy duty work.

Backstand idlers are of similar rugged construction, having adjustable counterbalances for belt tension.

For further information, a well illustrated folder containing specifications is available by writing to Mercury Metal Products Co., Dept. MF, 3475 Union Pacific Blvd., Los Angeles 23, Calif.

Rack Coating

A new solution for the coating of electroplating and pickling racks has been developed by The B. F. Goodrich Co., Dept. MF, Akron, Ohio, which embodies the chemical inertness of Koroseal tank lining. The new product is known as Korolac RX-2500.

A second new development, known as Korolac Primer No. A-208-B, is used in conjunction with the above to provide adhesion of the coating to the metal rack. This primer is brushed onto the rack and areas adjacent to the contact points, thereby preventing contamination of plating baths by carry-over of solutions underneath the protective rack coating.

The new coating is white, opaque and glossy. Hot alcoholic reverse current cleaners and such oxidizing acids as chromic and 40% nitric are claimed to have little or no effect. The resistance to organic solvent cleaners is also said to be remarkably good.

Metal Surface Measurement

Use of a stream of electrons to study the atomic structure of metals and gases and to identify invisible layers or films of foreign materials on metal surfaces has been developed into a practical process in U versity of Michigan chemistry laborator

The "electron diffraction" method of a alyzing metal surfaces has a host of prac cal uses in the fields of welding, lubrica ing, electro-plating, and painting. A spec machine based on the experimental mod developed by Prof. Lawrence O. Brockw is now being marketed commercially.

The machine produces a stream of 40,0 volt electrons in a vacuum chamber. In t center of the chamber is a specimen hol where the metal to be studied is plac This metal then interrupts the electr stream so that the electrons bend or bre off into new paths. As they do so, they e pose a photographic plate inserted at t end of the chamber.

Every metal placed in the vacuum tu breaks up the electron stream in a disti pattern, so that the photographs result from this process are different for ea metal. It is therefore possible to ident unknown substances in electron stream b comparing their diffraction patterns, photographs, with those of substances a ready identified, Prof. Brockway has e plained.

The particular value of the electron d fraction method is that it makes possible t study of the surfaces of metals. Metals a usually coated with a thin film of some su frequently an oxide of the metal itself perhaps by oil or some other foreign ma rial. These films diffract the electron bea in typical patterns also, which means th the surface layer of a metal may b identified.

Prof. Brockway explains that a metal c be identified by x-rays in this same fashi but x-rays are more penetrating than t electron stream and pass through the su face layer to the metal beneath. Thus on the electron diffraction method is usable the study of surfaces.

Thus far, the method has been used solving problems in welding, lubricati electro-plating, and metal cleaning.

Prof. Brockway's machine may be us by manufacturers of metal cleaning so tions, by industries using electro-plati and vulcanizing processes, and by ma facturers of paints which are used on meta During the war, the research work of t University of Michigan in this area was c ducted under contract from the Na Research Laboratory.

Although the electron diffraction proc is industrially useful because it makes p sible identification of unknown substances comparing their diffraction patterns w those of known substances, the method h a more fundamental use than this.

Electron diffraction facilitates the st

of the arrangement of atoms in molecules. The pattern made on a photographic plate may be measured to find distances between atoms in a given element or compound. Thus the method is enabling scientists to gain new knowledge of the basic structure of metals and vapors.

Rubber Apron

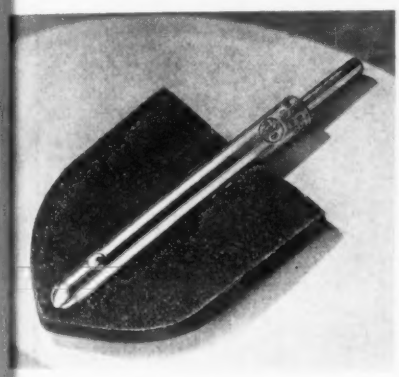
A new heavy duty, oil proof industrial apron made with Ameripol synthetic rubber has been added to its industrial clothing line, it is announced by The B. F. Goodrich Co., Dept. MF., Akron, Ohio.

The new apron size is 34" by 47", weighs 1½ pounds, and is hemmed throughout; it is fitted with four grommets.

The company has previously had a lightweight Ameripol industrial apron in its line.

Abrasive Pads

The Wilkinson Equipment Co., Dept. MF, 709 E. 69th St., Chicago 37, Ill., has been appointed sales distributor for RB Abrading Pads. Said to be ideal for internal and external finishing, these pads are used for



cleaning or polishing metal, wood, plastics, cast or pressed composition materials, glass, tile, plaster, cement, stone, asbestos, rubber, or synthetics. Other uses include internal grinding, deburring, chamferring, cleaning, finishing and polishing.

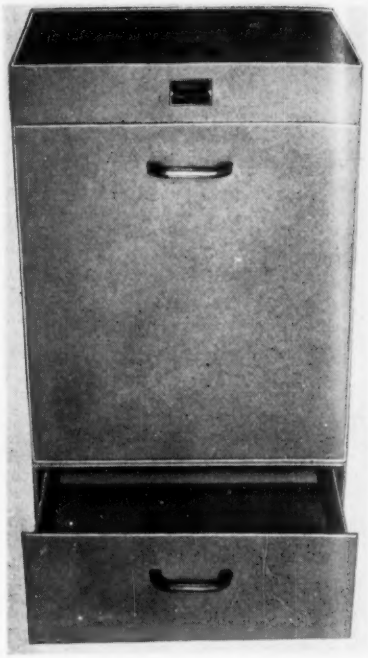
These new patented flexible abrading pads are made of from 2 to 14 plies of abrasive elements, die cut in four standard shapes. These come in sizes from ½ x 2 inches up to 9 x 10 inches to accommodate openings from ¼ to 6½ inches in diameter. Pads are available in grits from 24 to 320 grit.

Pads are attached to the driving mechanism of any lathe, drill press, flexible shaft, air or electric hand drill by either an internal or external mandrel.

Portable Dust Collector

An innovation in portable dust collectors has been introduced by the Dust Filter Co. of Chicago. The collector involves a new principle in portable collectors and is called the Dustex Dust Collector.

Unlike most tubular units which depend solely upon the filter tubes to separate the dust from the air, this unit causes the separation of high percentage of the dust at the point of intake, it is claimed. A baffle plate that is placed beneath the filter tubes is said to cause a rotation of the air and dust in a cyclone manner into the retaining pan



at the bottom of the unit resulting in a deposit of the dust at that point before it has an opportunity to reach the filter tubes. Consequently, no heavy dust or lint has the opportunity to reach the fifteen 36" long filter tubes at the top of the unit. All remaining fine dust is said to collect in the tubes. The company announces its experiments show that little maintenance is required because of the innovation. A static pressure of 6½" is maintained constantly.

The unit comes in one size only, is 4 feet high and approximately 2 square feet, is equipped with a 1½ HP, 3 phase, 220-440 volt motor and two 4" branch pipes. The company recommends it for use on buffing, polishing and grinding machines although they claim it has many other adaptations.

For further particulars, write Dust Filter Co., Dept. MF, 1753 W. Lake St., Chicago 12, Ill.

Plastic Plating Barrel

An outstanding illustration of the solving of industrial production problems by the use of plastics is a newly developed plating barrel made entirely of Du Pont Lucite acrylic resin.

The plating barrel, as indicated by its name, is used for metal plating by the tumbling method. Objects to be plated are held in a perforated container which is hung from the cathode bar and revolved in a vat containing the plating solution.

The new barrel is hexagonal and mounted on a moving stand which allows the machine gears and all, to be lowered into the solution vat. The gears are constructed of Lucite as well as the barrel itself. The plastic is resistant to the acid used in the plating bath.

The Hardwood Line Co., of Chicago, Ill., who originated the barrel and have a patent pending, experienced some difficulty with earlier models. Made chiefly of hard rubber they had to be constructed in panels which were joined to achieve the preferred hexagonal shape. In spite of careful construction, plated objects continually caught

the ribs where the panels were joined and made unloading difficult.

The new barrels have no ribs; they are of one-piece construction. The ends are cemented to the sidewalls. The loading door is a tightly-fitting, single sliding panel which forms one of the sides of the hexagon.

Another unsatisfactory tendency in the hard rubber barrels was that they became ionized in use and the solutions would in time plate on the rubber. The new plastic barrel is chemically inert and retains its low electrical conductivity.

A series of exhaustive tests disclosed several other advantages. The new barrel was found to withstand more abuse. It is easier to load and unload. Reinforcement is unnecessary. The barrel is more economically repaired and is said to wear longer than any model previously tested.

Electrical Tester

Announcement is made of a new combination safety test lamp and voltage indicator by Holub Industries, Inc. It is claimed this instrument, the "Hi" tester, is the inexpensive pocket type and offers the ultimate in safety, reliability and efficiency. It is equipped with a filament lamp and has a single test lead to prevent shorting the resistor.

The instrument is designed for use on AC or DC circuits to locate grounds, opens, blown fuses, motors running single phase, tracing control and other circuits, and to indicate approximate voltage. No fuses are required and it is stated that definite signals are given in brightly lighted as well as dark places without confusion.

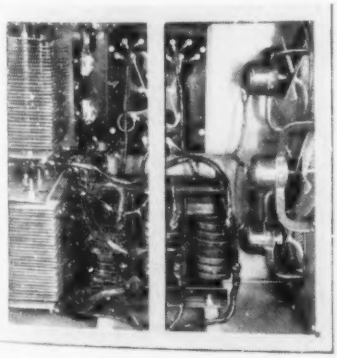
For further information write to Holub Industries, Inc., Dept. MF, Sycamore, Ill.

Selenium-on-Aluminum Rectifier

Development of an electroplating rectifier that is said to have everything is announced by Wagner Brothers, Inc., Dept. MF, 400 Midland Ave., Detroit 3, Mich., who will handle all sales nationally.

Claimed as without equal as a reliable and economical source of DC power, the Wagner-Tiedeman rectifier assembly employs metallic selenium-on-aluminum cells, known for their ability to handle momentary overloads of as much as 1000 per cent of normal capacity. Aluminum back plates in place of steel provide maximum cooling, and vitally essential low velocity air circulation is provided with a total amperage of only 1.5.

The rectifier reduces power costs drasti-



cally while maintaining extremely high efficiency, it is claimed offering an effective rectifying area of over 4300 square inches. The double-duty transformer is of the two-winding fully insulated type with ample reserve capacity.

Occupying a floor area of five and a half square feet, the rectifier is 34" high, 36" long, 22" wide, and the all steel welded enclosure is designed so that units may be stacked vertically for higher power.

Complete specifications are available in a detailed engineering bulletin.

Non-Slip Rubber Gloves

"Griptite," a new rough-surface finish which is said to permit a non-slip grip even in liquids, has been developed by the Surety Rubber Co., Dept. MF, Carrollton, Ohio, for its synthetic rubber gloves.

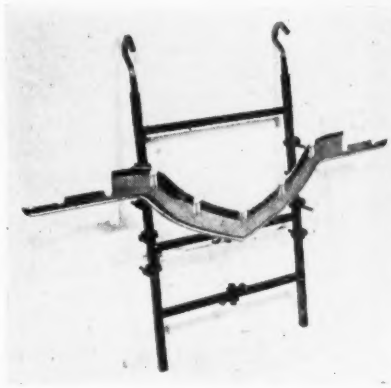
The finish is an integral part of the glove and will not peel or wear off, nor will loose particles break away while working in liquids, it is claimed.

The gloves are available in all standard weights and sizes, in turn-cuff and regular gauntlet styles, and with curved or straight fingers.

Insulated Plating Racks

Developers of a new method of fabricating plating racks, Duggan Masking Devices features pressure molded Neoprene insulation and interchangeable, replaceable adapters, claimed to give considerably longer life than conventional racks.

The process consists of a patented method of molding raw Neoprene, which is milled at their plant, directly to the metal framework of the rack by means of a hydraulic



press with electrically heated platens. The rack is made to fit accurately in a steel die which allows a predetermined thickness of coat, and the pressure held at 150 tons until the proper curing time of the Neoprene is attained.

Outstanding advantages claimed for the rack are its resistance to high temperature baths, secure bonding of the coating to the metal, high shock and abrasion resistance, and exceptionally long life due to inertness of the covering in all types of hot and cold alkaline and acid solutions. The manufacturer states that racks insulated by this method have been in operation continuously for two years in the copper-nickel-chrome cycle.

For further information and samples, write to Duggan Masking Devices, Dept. MF, 2030, W. Fort St., Detroit 16, Mich.

Titration Indicator

A new Methyl-Purple Indicator as a replacement for the usual methyl-orange solution has been developed by the Fleischer Chemical Co., manufacturing chemists.

Samples of the new indicator and literature on it are available by writing to the Fleischer Chemical Co., Dept. MF, P. O. Box 616, Benjamin Franklin Station, Washington 4, D. C.

Business Items

UNITED CHROMIUM APPOINTS MILLER

Curtis G. Miller has been appointed sales and technical representative for the Cleveland area by *United Chromium, Inc.* Mr. Miller, who served as Technical Officer with the Army Chemical Services, was formerly connected with the *Chromium Corporation of America* and the *McGean Chemical Co.* His appointment brings a highly qualified

Curtis G. Miller

technical adviser to the rapidly growing number of United Chromium customers in Cleveland and its surroundings.

Mr. Miller will make available to this important area all of the Unichrome processes and materials, which include plating processes, materials for the plating plant, synthetic coatings for product finishing, and the latest developments in industrial protective coatings.

PENNSALT SETS UP PACKAGING AND LABELING DIVISION

Rapidly expanding its activities in the field of chemical specialties and chemical products for consumers, the *Pennsylvania Salt Manufacturing Co.* has established a new Packaging and Labeling Division, which began operations in December.

George W. Benbury, packaging engineer, has been appointed manager of the new division. Mr. Benbury, who served in the U. S. Navy during the war, is an engineering graduate of North Carolina State College. He has been associated with Pennsalt since 1933.

Joseph A. Noone, a chemist with Pennsalt since 1937, has been named technical advisor on Labels and Registration. Mr. Noone attended Drexel Institute of Technology and graduated from St. Joseph's College in Philadelphia. ,

Edward W. Carter, formerly with the Pennsalt Greenwich plant laboratory, was named assistant packaging engineer. His chief duties will be studies leading to prepa-

Remember the American Electroplaters' Convention

One Week Beginning June 23rd, Statler Hotel

Detroit, Mich.

ration of package specifications for Company products.

Mr. Benbury, Mr. Noone and *Vance N. Wilson*, recently appointed supervisor of the Pennsalt tank car fleet, have been named company representatives on various industry committees, replacing *L. L. Hedgepeth*, who recently resigned from Pennsalt to become executive secretary of the Virginia State Water Control Board.

H. R. SHAEFFER RESIGNATION ANNOUNCED

The resignation of *H. R. Shaeffer*, vice-president in charge of sales of the *Malone Bronze Powder Works, Inc.*, New York City, effective January 1st, has reecently been announced.

Mr. Schaeffer expects to announce his plans for the future after his resignation becomes effective.

HEIL APPOINTS WEPPNER

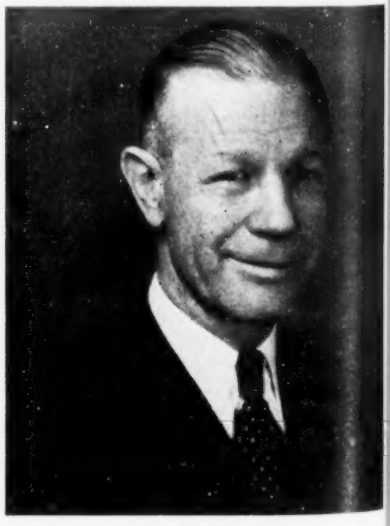
Heil Process Equipment Corp., of Cleveland, Ohio, announces the appointment of *Richard A. Weppner* as sales representative to cover the Philadelphia territory. Mr. Weppner will make his headquarters at 11 N. Lynnwood Ave., Glenside, Pa.

Mr. Weppner is a graduate chemical engineer and is thoroughly familiar with chemical equipment problems. He will handle the company's line of process tanks, process tank heaters, and special tank linings.

MOULTON AND BUIST NAMED TURCO SALES CHIEFS

Appointment of *L. H. Moulton* to the post of national sales director and *D. T. Buist* assistant national sales director, was announced recently by *Ray Sanders*, vice-president and general manager, *Turco Products, Inc.* Their headquarters will be the firm's main offices in Los Angeles.

These appointments mark another step in the growth of this concern which manufactures several hundred specialized cleaning and processing compounds for industrial finishing and 21 other industries here and abroad. During the past two decades the firm has established four factories in Le



Lou Moulton

Dan Buist

Angeles, Houston, and Chicago. Selling direct to the industrial consumer, they maintain sixty-five warehouses and sales offices.

Fifteen years' experience in the selling of Turco's chemical line gives Lou Moulton the necessary qualifications to direct the nationwide sales-service staff. A graduate of Colorado College of Agriculture, Mr. Moulton was well known in the dairy and allied industries for many years, joining the staff in 1931. For the past eight years he has directed their Eastern Division from the Chicago plant office.

Dan Buist joined the company in 1936 as a specialist with 20 years' experience in the automotive field. Transferred to the Aviation Division in 1939, he was promoted to district sales manager in 1943, and western zone sales manager in 1944.

HOGARTH NAMED PENNSALT PURCHASE ENGINEER

Barton I. Hogarth, graduate mechanical engineer, has been named to the newly-created position of purchase engineer in the Equipment and Supplies Division of the *Pennsylvania Salt Manufacturing Co.* Purchasing Department, *N. W. James*, general purchasing agent, announced.

Mr. Hogarth came to Pennsalt from the *Manhattan District Project*. He formerly was associated with the *Carbide and Carbon Chemical Co.* at its South Charleston, West Virginia and Texas City, Texas plants. A native of Williamsport, Pa., Mr. Hogarth is living at 4635 Castor Ave., Philadelphia. His work in the new division will be in connection with equipment and accessories, Mr. James said.

MONSANTO COMPLETES INSTALLATION

Monsanto Chemical Co. announced the completion of final installations for phosphoric acid and sodium phosphate manufacture at its plant in Trenton, Mich.

The shift of phosphoric acid and sodium phosphate operations from Monsanto's Anniston, Ala., plant began with the Trenton plant in 1942, but was delayed because of wartime restrictions. Sodium phosphates now produced at Trenton include monosodium phosphate, disodium phosphate, trisodium phosphate, tetrasodium pyrophosphate, sodium acid pyrophosphate and polyphosphates. The production of tetrasodium pyrophosphate, formerly carried on at the company's Monsanto, Ill., plant, also has been shifted to Trenton.

BROWN INSTRUMENT IN NEW TULSA SITE

The *Brown Instrument* division of *Minneapolis-Honeywell Regulator Co.* has opened a new branch office at 117 W. Eighth St., Tulsa, Okla., in charge of *R. P. Walker*, branch manager.

The new location, within a few blocks of Tulsa downtown oil company offices, includes storage space for instrument accessories, supplies and emergency repair stock, permitting the Brown company to render extended maintenance and servicing.

SAMPLE JOINS INTERNATIONAL NICKEL

Clarence H. Sample, formerly chief engineer of Rheem Research Products, Inc., has joined the Electroplating Section of the Nickel Sales Department of *The International Nickel Co., Inc.*, at New York.

He will make his headquarters at New York and will work on the development and sales of nickel plating.

Mr. Sample has a B. S. degree in Chemical Engineering from the University of Idaho and an M. A. in Chemistry from Columbia University. From 1930 until October 1945 he was on the technical staff of the *Bell Telephone Laboratories, Inc.* at New York, where his duties included research and development on corrosion and metallic finishes.

He is a member of the American Society for Metals, the American Chemical Society and the Electrochemical Society. Mr. Sample is also active on several committees

of the American Society for Testing Materials, in which he is currently secretary of Committee B 8, Electrodeposited Metallic Coatings.

WYANDOTTE CHEMICALS MEN GET WATCHES

Twenty-five members of the *Wyandotte Chemicals Corp.* sales force, *J. B. Ford Division*, were recently awarded gold watches for completing 25 or more years of service. The watches were presented at a banquet at Wyandotte, Mich., attended by nearly 500 company executives, research personnel, production workers and salesmen. Honored guests were the 25 J. B. Ford Division salesmen and 350 other employees who had achieved their quarter century or more of service during the war years when civilian watches were not available. The combined service of the 25 men totals 724 years of experience.

EICHSTAEDT JOINS SOUTHERN PLATING

Theodore C. Eichstaedt recently joined the *Southern Plating and Refinishing Works*, 235 Second Ave., South, St. Petersburg, Fla., as Superintendent. Mr. Eichstaedt has as his address P. O. Box 3071, St. Petersburg, Fla.

Manufacturers' Literature

Lead Anodes

A new pamphlet recently released by the *George L. Nankervis Co.*, gives construction and design data on their *Republic* homogenious chrome plating lead anodes.

Line drawings explain the design of the anodes to give maximum throwing edges for the chrome plating cycle. Hooks are burned, not cast, into the anode, which is claimed to give an integral bond assuring positive electrical contact over the entire anode life and which is said to mean even wear over the full length of the anode. Reinforced at the solution level to give added strength, the anodes are claimed to give maximum service.

Several designs of hooks and hook angles are pictured, and instructions on breaking in new anodes for longer life are given. Ordering directions are also listed.

To secure copies of this folder write George L. Nankervis Co., Dept. MF, 5442 Second Blvd., Detroit 2, Mich.

Buffing Wheels

A 12-page booklet describing construction, fabric and workmanship of their various type bias-cut buffs has recently been released by *The Bias Buff and Wheel Co.*, Dept. MF, 3464 Hudson Blvd., Jersey City 7, N. J.

Illustrations explain the principle of bias-cut fabrics in polishing and buffing operations and claimed advantages over loose type buffs are listed. Lathe speeds recommended for their wheels, listing diameter of wheels and diameter of flange, are also given.

To obtain a copy of this booklet, inquire on firm stationery to the address above.

Belt Polishing Equipment

A new folder has recently been released on several types of backstand idlers, polishing and buffing lathes, segmented rubber wheels and other abrasive belt grinding equipment.

The floor type backstand idlers are illustrated with single or double pulley attachments; polishing and buffing lathes are shown for use with the idler. A patented cushioned roll for use on idler equipment is also pictured. The wheel has an outer hard rubber surface while the center is of softer rubber, which is said to give the roll true form for shape polishing and grinding.

For copies of this folder write to *Ryman Engineering Co.*, Dept. MF, Ellwood City, Pennsylvania.

Corrosive Fume Exhaust Fans

A new 12-page bulletin on corrosion-resistant fans for exhausting acid and other corrosive fumes has just been published by *The Duriron Co., Inc.*, and is available on request.

This bulletin gives complete engineering data including dimensions and capacities of the five standard sizes of fans made by the company. A description of *Duriron*, *Durichlor* and *Durimet*, the special cor-

rosion-resisting alloys of which the fans can be built, is included. The booklet points out that the alloy used in constructing each unit depends upon the type of corrosive service it will encounter.

Some of the typical applications for the fans are shown by drawings in the bulletin. These include exhausting fumes from laboratory hoods, plating, pickling and anodizing tanks, hydrochloric acid etching installations, reaction kettles, sulfuric acid chamber processes, absorption or drying towers, Kjeldahl tubes, fume washers, etc.

The booklet also includes information on the type of drives used, as well as hood outlets, bell end adapters and drip traps. In addition complete instructions are given on how to specify, how to select and how to order the correct fan for a particular application.

A free copy of this bulletin can be obtained by writing to The Duriron Co., Inc., Dept. MF, Dayton 1, Ohio and requesting bulletin 1102.

Corrosion Resistant Coating

A new 4-page descriptive folder on *Ucilon* gives properties, application data, and typical uses of this protective coating that is said to resist severest corrosive conditions. Developed from improved, inert, synthetic resins, this material is claimed to be especially advantageous for maintenance work, and for products subjected to corrosive service.

To obtain a copy write to *United Chromium, Inc.*, Dept. MF, 51 E. 42nd St., New York 17, N. Y.

Abrasive Belt Polishing Equipment

A tremendous advance in the efficiency of abrasive belt polishing is claimed thru the use of *Presto* contact wheels and backstand idlers as described in the new *Bulletin* 104 issued by The Manderscheid Co., Dept. MF, 810 Fulton St., Chicago 7, Ill. Copy mailed promptly on request.

Sand Blast Hose

A new catalog leaflet on its sand blast hose, designed specifically for conducting sand and other abrasive materials at high velocities for cleaning, cutting or finishing castings, stone, glass and metal surfaces has been published by *The B. F. Goodrich Co.*, Dept. MF, Akron, Ohio, and is now available upon request. The leaflet describes construction of the product, and gives data on sizes, weight per hundred feet and outside diameters.

Voltage Control Equipment

A new twelve-page bulletin has been released by *The Superior Electric Co.*, Dept. MF, Bristol, Conn., specialists in the manufacture of voltage control equipment.

The bulletin clearly illustrates and describes *Seco's* complete line of variable transformers, automatic voltage regulators, a-c power supplies, and special custom-built equipment such as remote positioners and theatre dimmers.

Detailed description including many charts, graphs, and dimensional drawings makes this bulletin complete for engineers seeking the answer to voltage control problems.

The company will forward copies to all interested parties.

Sand Blast Hose

Described as "extra-tough," *Monarch* brand sand blast hose is the subject of a new four-page folder now being distributed by *Hewitt Rubber of Buffalo*, a division of *Hewitt-Robins, Inc.*

Highly flexible despite its toughness, the tubing is claimed to have ease of handling in such uses as sand blasting foundry flasks, castings and other metal surfaced pieces. It is also used in cleaning stone or brick, and the inside tube and cover are compounded to resist the abrasive action of sand.

Copies of the printed folder may be obtained by writing Hewitt Rubber, Dept. MF, 240 Kensington Ave., Buffalo 5, N. Y.

Letters to the Editor

Metal Finishing Inc.
11 West 42nd Street
New York 18, New York

Your chart entitled "Ordinary Nickel Plating Faults" in the October issue of *Metal Finishing* should either be retracted or modified at the earliest possible moment.

The itemized Fault and Correction may have been true and applicable fifteen years ago, however with the advent of bright nickel it would be a catastrophe to anyone using means of correction as recommended. I am not writing this letter in a spirit of criticism, but to help avoid, if not too late, for anyone who is using bright nickel, from untold rejects, spoiling of plating solution and

eventual shut down and necessitating pulling of the plug.

In step two "Porous Deposit" Ammonium Sulfate addition was recommended. In step three "Bright Streaks and Pitting", Ammonium Hyroxide addition was recommended. Ammonium salts or Ammonia are absolutely taboo in any bright nickel solution in quantities, however small. Ammonia in any form causes brittle nickel, once introduced cannot be removed and the solution must be discarded.

In step six "Roughness Caused by Colloidal Matter", it was recommended to add Hydrogen Peroxide, Sodium Peroxide, Sodium Perborate, Sodium Fluoride or Potassium Permanganate. Here again in bright nickel plating, the only permissible oxidizing agents are Hydrogen Peroxide and Potassium Permanganate. Sodium Salts and Fluorides should be kept out. With the addition of an oxidizing agent the solution should be at a high pH of above 5.0 and requires an activated carbon treatment of from 2-5 pounds of carbon per 100 gallons of solution and filtered after three or four hours settling.

Yours very truly,
W. R. B.

Metal Finishing,
New York 18, N. Y.

Gentlemen:

The answer to the problem of Disposal of Zinc bath asked by R. D. H. in your November issue was, to my mind, answered very inadequately. This problem has never been solved satisfactorily, and I think it is about time that something definite was established to take care of it.

In this specific instance, the answer presupposes a sewage disposal plant, which is not always available. I have in mind an experience of my own in dumping about 200 gals. of zinc into the sewer, which flowed into the river about one-half mile away and killed 10,000 fish in a 25-mile stretch of this river. It is not enough to say that the solution should be diluted when dumped, as the solution referred to was diluted about 500-1. I have a faint recollection that some years ago a paper was delivered on this problem at an A. E. S. convention. This should be resurrected and gone over very thoroughly, and perhaps something can be developed which will fit into the everyday disposal problem of the small shop as well as the large.

Very truly yours,
H. M. Q., Inc.
By G. S.

New Books

This second, enlarged and up to date edition of *Finishing Metal Products* by *H. R. Simonds* and *A. Bregman*, is a welcome edition to the growing literature of the industry.

It is not a handbook for engineers or chemists but is the kind of reference book that a finishing room foreman should have. It contains a wealth of information on practically all kinds of finishes for the metal products industry. Information ranges from standard plating formulas to cost analysis and to an understanding of the value of finishes for selling different types of commodities. It is, because of the panoramic view it provides on metal product finishes, the kind of book that men in the industry should consult before deciding on what kind of finish they want for their product.

Without listing each separate heading it is sufficient to say that in addition to cost analysis of finishes and sales analysis descriptions there is a study of the all important factor of cleaning metal before any type of finish is applied. The value of various finishes is discussed from the appearance, corrosion resistance, and functional points of view. Chapters of wide interest deal with synthetic finishes, buffing, coloring aluminum, enameling steel and new developments in porcelain enameling of steel.

Published by McGraw-Hill Book Co., Inc. the price is $4.00.

(Reviewed by B. Robertson, Consultant).

News from California
By FRED A. HERR

Rubber Plated metal is the odd name applied to the technique of bonding rubber to steel which, according to *W. S. Long*, Pacific Coast manager, *United States Rubber Co.*, received a strong impetus by the heavy development of the chemical and chemical process industries in the West during the war years.

One of the largest users of the rubber plating process in Southern California is the *Fairbanks-Morse Co., Pomona* plant, which firm, in collaboration with U. S. Rubber Co. designed a rubber lined system of pipes for use in the removal of aciduous water from

eastern coal mines. Two important features in the development of rubber plating, according to Long, are that rubber offers excellent resistance to corrosion, and that it is possible to bond rubber to steel.

A 75-foot-long Acme finish spray booth which will accommodate the largest trailer bodies produced by the firm is among the new equipment installed in the enlarged plant of the *Fruehauf Trailer Co. of California* at Vernon, Calif. Three coats are applied to the stainless steel trailer bodies. Average drying time is 45 minutes. Another piece of major equipment in the enlarged plant is a 70-foot-long baking oven which was designed and built to Fruehauf needs by the *Ross Engineering Corp.*

Julius J. Witte, head of the *Witte Plating Works*, Chicago, for the past 40 years, and a charter member of Chicago Branch of the A.E.S., has turned the management of the firm over to his sons *Ted*, *Bob* and *Fillmore*. He arrived in Los Angeles early in December for a visit which, he said, may become permanent. He is visiting with another son, *Elmer*, foreman of the *Cadmium & Nickel Plating Co.* of Los Angeles.

The wives of two past-presidents of Los Angeles Branch of the A.E.S. passed away recently. *Mrs. Robert Gripp*, wife of the late *Bob Gripp*, who was foreman of *Cadmium & Nickel Plating Co.* until his death this past summer, died in mid-November. *Mrs. Flora Sunderhaus*, wife of *Joseph Sunderhaus*, passed away after an illness of five years earlier in November.

The *Los Angeles Plating Co.*, operated at 6921 Avalon Blvd. by *Laurence Rotollo*, is one of the most extensive users in the West of hard chrome for plating automotive, aircraft and marine engine equipment, a field to which Rotollo was introduced during the war. The firm was organized in 1939 and now occupies a plant enlarged considerably over the original new building erected in 1942.

Hugo Hiemke, formerly research supervisor for the War Metallurgical Committee of the National Research Council, has been appointed assistant director of research of the *A. O. Smith Corp.* development laboratory at Los Angeles.

John A. Ruthven, *Harry A. Smith* and *M. J. McCully* are associated in the operation of the *Quality Plating Co.*, Los Angeles, which recently was issued articles of incorporation.

Ducommun Metals & Supply Co. of Los Angeles has announced the election of *Edmond D. Ducommun* as president to succeed the late *Emil C. Ducommun*. *A. W. John* was elected executive vice president, *Charles E. Ducommun*, vice president and treasurer; *Wayne Rising*, vice president and general manager; and *Elmer Wall*, secretary-treasurer.

Associations and Societies

AMERICAN ELECTROPLATERS' SOCIETY

There has just been issued under the joint sponsorship of the American Society for Testing Materials and the American Electroplaters' Society a compilation of standard specifications and tests for Electrodeposited Metallic Coatings. These two organizations have been cooperating for a number of years in research and standardization work. The A.S.T.M. activity in this field is carried out by its Technical Committee B-8 on Electrodeposited Metallic Coatings.

In the compilation are given specifications for various types of coatings on steel and non-ferrous metals—zinc, cadmium, nickel and chromium, and lead. There are requirements for nickel and chromium on copper and copper-based alloys and on zinc and zinc-base alloys and there is a specification which covers chromate finishes on electrodeposited zinc (hot-dipped galvanized and zinc die-cast surfaces).

Two tests methods which have come into rather wide use are given, one covering salt spray testing (B 117) the other tests for local thickness of electrodeposited coatings (A 219).

The book is made more complete by the inclusion of two recommended practices one pertaining to chromium plating on steel (B 177) the other preparation of low-carbon steel for electroplating (B 183).

Copies of this new 52 page publication, entitled *Sepcifications and Tests for Electrodeposited Metallic Coatings,* 6 by 9 in., which should be of interest to all those concerned with the subjects covered can be obtained from A.S.T.M. Headquarters, 19[illegible] Race St., Philadelphia 3, Pa., at $1.25 each. Special prices are quoted on orders in quantity.

LOS ANGELES BRANCH

Paul Koeckritz, co-owner of the *Los Angeles Parkerizing Co.,* was the principal speaker at the December 9 meeting of Los Angeles Branch, American Electroplaters' Society, at the Cabrillo Hotel, delivering an extemporaneous talk on *Parkerizing* and its application to and connection with the metal industry.

Appearing for *Sam Hedley,* West Coast representative of the *Parker Rustproofing Co.,* who was unable to attend, Mr. Koeckritz declared that the purpose of his talk was to shed some light on phases of the process that are usually not generally known to the average plater.

The speaker declared that the method has become a standard of finishing for rustproofing by scores of industries wherever iron and steel are fabricated. Among recent improvements which have been made in the art of rustproofing he cited shortened processing time, lower operating temperature, improved chemicals, smoother coating and lower application and equipment costs.

Koeckritz described the process as one which involved a chemical conversion where by the surface of iron or steel are changed to an insoluble phosphate coating that is highly resistant to corrosion. He presented a detailed description of the process involved, solutions and equipment required to accomplish a satisfactory job.

An animated 45 minute question-and-answer period followed the conclusion of Mr. Kroeckritz's talk. In answer to a question, "Can Parkerizing be plated?" he replied.

"Some cases have been known where plating has been accomplished with a degree of success. However, it is not recommended as it is not known how the plating will 'take' or react. It is a non-conductor of electricity and therefore is difficult for a plating deposit to set itself on a Parkerized surface."

President D. N. Eldred presided at the business session. *John J. Sanford* of Progressive Plating Co., *Herbert Zagor,* and *B. C. Bonnejee* of the Bonnejee Jewelry Mfg. Co. were initiated into membership. The transfer of *M. H. Orbaugh,* formerly with Bone Engineering Co., Glendale, Calif., from Los Angeles to the Detroit Branch was approved.

The following guests were introduced: *Julius J. Witte,* charter member of Chicago branch, and retired head of Witte, Plating Works, Chicago; *Kenneth Medling,* Plomb Tool Co.; *L. K. Shoals,* Latex Seamless Products Co.; *Howard Sterling,* Plomb Tool Co.; *L. A. Peterson,* the Oakite Co., member of Chicago Branch; *A. Jackson,* Jackson Brass Foundry; *C. W. Jackson; C. L. Stuart-evant,* Modern Engineering and Development Co.; *John J. Sanford,* Progressive Plating Co.; and *James Bentley,* Harshaw Chemical Co.

Secretary Emmette Holman reported the branch's efforts to assemble a complete file of back numbers of the *Monthly Review* for presentation for reference purposes to

the Los Angeles Public Library was proceeding exceptionally well. Complete files back to 1934 are ready for binding, he reported. *Marcus Rynkofs* and *Frank Rushton* contributed back numbers dating to 1918, the missing numbers to be obtained, Holman reported, by exchanging extra copies of other years through the office of the Supreme secretary.

The branch voted to instruct delegates to the 1947 national convention to favor the suggestion of *Walter Pinner*, chairman of the constitution committee, that the constitution be set aside temporarily at the next convention in order to permit a new and revised constitution to be balloted upon.

It was reported that the committee of past-presidents named at the November meeting as an arrangements committee for the 1947 educational session, had chosen *D. N. Eldred* as general chairman, and *Earl Coffin* and *John Merigold* as co-chairmen. Eight speakers have been definitely or tentatively arranged for appearance at the session, which will be held at the Los Angeles Breakfast Club March 22, 1947, in the form of morning and afternoon business sessions, followed by the annual banquet in the evening.

GRAND RAPIDS BRANCH

The annual educational session and dinner dance of the *Grand Rapids Branch* of the AES to be held February 1, 1947 has recently been announced. Chairman of the educational session is *Frank K. Savage*, supreme president of the American Electroplater's Society.

Three talks are scheduled, beginning at 2:00 P.M. *Walter A. Moline* will speak on *Electrolytic Deburring; Maurice R. Caldwell* will present *Recent Developments in the Finishing of Zinc Base Die Castings;* and *Notes on Nickel and Chromium Plating* will be given by *C. F. Nixon.*

An informal dinner-dance is to be held in the evening, with entertainment. *Mr. John Pulte* is in charge of table reservations.

DETROIT BRANCH

The ninth annual educational session and dinner-dance of the *Detroit Branch* of the American Electroplaters' Society was held at the Hotel Statler in Detroit on December 14, 1947. *Mr. Carl Heussner* was chairman of the educational session.

Three talks were presented: *Manufacture of Quality Zinc Base Die Castings*, by *J. C. Fox; Plating of Die Castings*, by *Cleveland Nixon;* and *Testing of Plating on Die Castings*, by *Dr. A. E. Anderson.*

The dinner-dance held in the evening was attended by more than a thousand electroplaters, their wives, friends and families. *G. L. Nankervis*, general chairman of the *Industrial Finishing Exposition* which is to be held in Detroit June 23 to 27, 1947, announced at the dinner that the Detroit Branch had leased the entire Convention Hall in Detroit for the Exposition.

DAYTON BRANCH

The highlight of the November meeting of the Dayton Branch of the American Electroplaters' Society was the presentation of the *Toulmin Trophy* to *L. A. Critchfield* of the Dayton Branch.

Mr. Critchfield used for his subject, *Plating Rack Coatings.*

The Toulmin Trophy is presented each year to any member of the Columbus, Cincinnati, Indianapolis, or Dayton Branch for the presentation of the best paper given at any of the Branch meetings.

All papers are judged by the three immediate past presidents of the Supreme Society. Mr. Critchfield's Paper may be found in the February issue of the *Monthly Review.*

BALTIMORE-WASHINGTON BRANCH

A record breaking crowd attended the December, 1946 meeting of the Baltimore-Washington Branch of the American Electroplaters' Society to hear *Dr. Edward Wichers,*

chief of the Platinum Metals Section of the National Bureau of Standards, delivered a lecture on atomic energy illustrated with blackboard sketches and a 30 minute sound movie in color of the Bikini Atom Bomb Tests. Dr. Wichers, one of the scientists who assisted in atomic bomb research at Los Alamos, New Mexico and one of the few who witnessed the first atomic explosion, addressed his audience in layman language on the recent developments in nuclear disintegration for the production of atomic energy for industrial and medical purposes. He predicted that atomic energy may be used for civilian purposes within the next ten years.

The January, 1947 regular meeting of the Baltimore-Washington Branch will be a trip through the plant of the *Rustless Iron and Steel Co.*, of Baltimore, Md. A number of the officials of the company are expected to address the members of the Branch after the tour through the plant. There will also be a question and answer period.

INDIANAPOLIS BRANCH

The fourth annual regional meeting of the *American Electroplaters' Society* for Indiana and Ohio, which includes the Cincinnati Branch, Dayton Branch, St. Joseph Branch, and the Indianapolis Branch, will be held at the Indianapolis Athletic Club in Indianapolis, March 29, 1947.

The meeting will include an education session, a symposium of the problems of copper nickel and chromium plating, as well as a banquet, entertainment and dance.

Registration and ticket reservations may be had by writing *Walter R. Binai*, 26 [illegible] Sheridan, Indianapolis, Ind.

CHICAGO BRANCH

The thirty-fifth annual educational session and dinner dance of the *Chicago Branch* of the *American Electroplaters' Society* is to be held on Saturday, January 25, 1947, at the Stevens Hotel.

The educational session in the North Room will begin at 2:00 P. M. and will be a symposium on zinc base die castings, covering manufacture, finishing practice and procedures. The talks are to be as follows:

1. Manufacture, by *R. F. Burns*, The New Jersey Zinc Sales Co.

2. Polishing and Buffing, by *C. F. Ma*[illegible] or *R. C. Olsen*, Fisher Body-Ternstedt Division, General Motors Corp.

3. Cleaning, by *H. Strow*, MacDermid, Inc.

4. Plating, by *R. M. Wagner*, Guid Lamp Division, General Motors Corp.

5. Electrolytic Purification of Plating Solutions, by *C. E. Heussner*, Chrysler Engineering Laboratory, Chrysler Corp.

Dinner will be served in the Grand Ballroom at 7:00 P. M. followed by a floor show and dancing. All tables are set for ten and all seats may be reserved by contacting *M. Longfield*, 1528 S. 61st Ave., Cicero, Ill.

AMERICAN SOCIETY FOR METALS

WESTERN METAL CONGRESS

The best practical and technical program ever presented to the metal industry at a *Western Metal Congress* is taking shape, according to *Dr. John E. Dorn*, Assoc. Prof. of Metallurgy, University of California, Berkeley, and chairman of the program committee of the Congress which will be held at Oakland Municipal Auditorium, March 22 to 27, 1947.

"Some of the most outstanding scientists and research investigators of the United States have accepted invitations to appear on the program," says Dr. Dorn. "The program will cover practically every phase of the manufacture, production, fabrication, inspection, testing, welding and use of metals."

Assisting Dr. Dorn in the work of the program committee are *Prof. Cutler Shepard* of Stanford University and *Mr. Fred Donley* of the Caterpillar Tractor Co., San Leandro, vice chairmen of the committee, together with representatives of the fifteen national technical and engineering socities having branches in the West that are cooperating in the Congress.

The *Western Metal Exposition*, which will be held simultaneously with the Western Metal Congress, has already received applications from more than one-hundred leading metal manufacturers of the East and West for the privilege of participating in the exposition, which will occupy over one-hundred-thousand square feet of space.

This is the fifth Western Metal Congress and Exposition held in the West under the auspices of the *American Society for Metals*.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

Arrangements have been completed to have *Dr. Norman Hackerman*, professor in the School of Chemistry, University of Texas, address the members of the National Association of Corrosion Engineers, who will convene in Chicago, Ill., April 7 through 10, 1947, according to *Dr. R. B. Mears*, chairman of the NACE Program Committee.

Dr. Hackerman, an authority on the use of inhibitors in combating corrosion, will speak on the topic, "Mechanism of Inhibitor Action." The Address will follow closely the developments in this line that Dr. Hackerman has made during the past years in his research on the subject, both personally and with his colleagues at the University of Texas.

According to Dr. Mears, Dr. Hackerman will speak before the General Industry Symposium, one of five technical sessions which will be held during the four-day conference and exhibition.

Dr. Mears also announced that co-speakers on the General Industry Symposium will be *Mr. J. T. Gow* of the Battelle Memorial Institute; *B. G. Crane*, member of the Ethyl Corp. Research staff, and *N. E. Berry*, director of research for the Servel Corp. Mr. Gow,

well acquainted for his brilliant work in the corrosion research field, will offer as his subject, "Oxidation of Stainless Alloys." Mr. Berry, who long has been associated with research in connection with deterioration of foods, will discuss recent studies in "Thermogalvanic Corrosion," while Mr. Crane will deliver a paper, "Non-Destructive Methods of Determining Metal Plate Thickness," which he prepared in collaboration with *J. G. Kerley*, of the Shell Oil Co. research laboratory.

In addition to the five technical sessions scheduled during the four-day period at the Palmer House in Chicago, there will be an exhibition featuring the latest developments in material, services, equipment and devices now used in the fight to eliminate this country's $6 billion annual corrosion loss. The exhibition will be open daily during the convention from 9:30 a.m. until 5:30 p.m. and will be open to the public.

How Much Do You Know?

By George Black

The increasing availability of magnesium alloys makes it imperative that finishing personnel be familiar with the details of the methods used for their protection from corrosion. If you can fill in the missing words, the following paragraph will provide a short summary of present day treatments.

The cleaning of unmachined rough surfaces is accomplished in a (1) ..... pickle, but the use of (2) ..... acid is recommended for machined parts. Just prior to the surface treatment, a final cleaning in a strong (3) ..... cleaner is required. For temporary storage or domestic shipment the (4) ..... is used. If longer protection is desired this last treatment may be (5) ..... These treatments are only suitable when close dimensional tolerances are not required. The (6) ..... treatment does not affect dimensional accuracy, but it is not suitable for alloys high in (7) ..... (8) ..... is recommended for these alloys. Treatment with (9) ..... is recommended where low electrical resistance is needed. The (10) ..... treatment supplies a decorative black finish, while the borax treatment offers a hard decorative film which is gray in color.

(*See Answer Key on page 93*)

Christmas Greetings

Christmas greetings were received from the following:

H. Leroy Beaver
T. R. Bogess
Adolph Bregman
Cabot and Co., Inc.
Champion Chrome Plating Co.
David X. Clarin
Harry Coleman & Co.
L. A. Critchfield
Austen Fletcher
Greiser and Leffel
George W. Grupp
Mr. and Mrs. L. M. Hague
Donald A. Hilliard
Hinterleitner Associates
Hercules Powder Co.
Carl Heussner
Tom Haddow
Mr. and Mrs. George B. Hogaboom
Mr. and Mrs. E. Huenerfauths
Elmer E. Huppert, Jr.
John E. Huyler
Thalia and Franklin Johns
George Karl
Ernest Lamoureux
Charles F. L'Hommedieu & Sons Co.
Lotte Chemical Co., Inc.
F. J. MacStoker
J. G. Malool
The Glenn L. Martin Co.
Wilfred S. McKeon
Mercready and Co.
J. B. Mohler
Philips Webb Upham and Co.
H. K. Porter Co., Inc.
The Puritan Mfg. Co.
Andrew V. Re
L. W. Reinken
Schiff, Terhune and Co., Inc.
Arthur P. Schulze
Genevieve and Willoughby Sheane
Catherine and Horace Smith
Bill and Bob Towne
Tutrone Printing Co., Inc.
O. S. Tyson and Co., Inc.
United Air Lines, Inc.
United Chromium, Inc.
Universal Engraving Co.
Lionel de Waltoff
Samuel Wein

Thank You! And Cordial Greetings and Best Wishes to All Our Friends.

ANSWER KEY

1. nitric-sulphuric
2. chromic
3. alkali
4. chrome-pickle
5. sealed
6. dichromate
7. manganese
8. galvanic anodizing.
9. chrome-sulphate
10. chrome-alume

DEVELOPMENTS

(*Continued from page 55*)

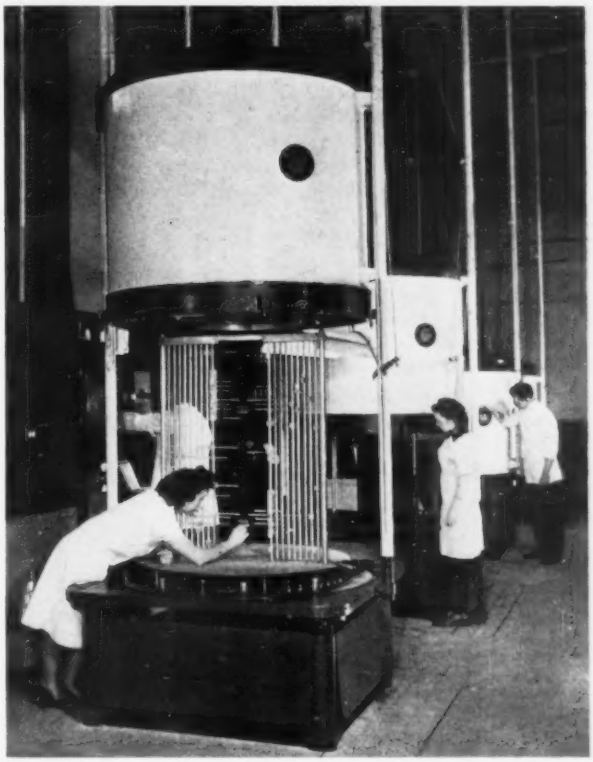
and pointed out the necessity for proper safeguards. *Stream pollution* problems due to electroplating wastes was examined by Oeming.[192] The author gave methods for treating various wastes to concentrations below toxic values. Another paper on the treatment of cyanide and acid *plating room wastes* was presented by Herda,[193] indicating the mounting interest in this subject.

Malcolmson and Miner[194] *coated aluminum* by anodizing, coating the surface with an organic salt of a noble metal, then heating the article to decompose the organic material, while Gilbert[195] *coated aluminum and magnesium* by contacting the surface with the halide of a metal, then removing the halide by immersing the work in a solution of an alkali metal hydride in alkali metal hydroxide. Hopkins[196] *deposited tin* on an iron surface by the use of powdered tin and a co-polymer of vinyl chloride and vinyl acetate, heating the mass to effect fusion; the vinyl coating acted as a flux in the tin fusion step, according to the author.

Copper was recovered from dilute solutions of its salts by Tiger and Goetz.[197] Lum[198] *stripped copper* from zinc without affecting the base metal by making the work anode in an aqueous solution of an alkali metal cyanide and an alkali metal oxide. *Lead, lead-tin and lead-indium was stripped* successfully by Heath, Fisher and Holbrook[199] from steel by the use of 95% glacial acetic acid and 5% hydrogen peroxide (30%).

Doutz and Romig[200] were granted patents for the *phosphate treatment* of ferrous metals, while Jernstedt and Lum[201] prolonged the life of *phosphate coating solutions by means* of maintaining a minimum of 0.10% dissolved iron in the solution.

Irenas[202] examined the significance of *water* in the plating room and discussed the composition of industrial water and its effect on plating solutions and deposits, while Morral[203] made a comparison of the tolerated *impurities in plating solutions* and those



The world's first volume production of transparent mirrors —glass that transmits light as well as reflecting it — is announced by Liberty Mirror Division of Libbey - Owens - Ford Glass Co., Brackenridge, Pa., where thermal evaporation chambers shown are used to surface glass by a method of molecular "bombardment" with chrome particles. The development is the first peacetime application of a highly secret wartime advance in glass technology.

introduced by tap water, pointing out the need for more fundamental data and that water, as the principal constituent, can be controlled by demineralization in *ion-exchange equipment.*

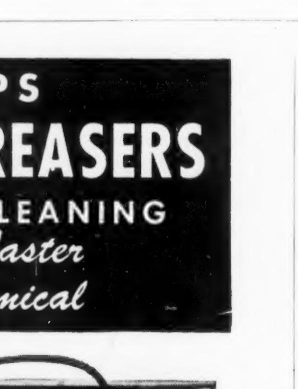
Buck[204] gave excellent tables and information on calculating *coil and burner requirements* for gas-fired immersion heating. A thorough discussion of *tank design* and materials of construction from a practical standpoint, including costs, was given by Hogaboom and Hall.[205] Sussman[206] explained the *laws of electricity* governing direct current circuits and their application to *rheostat construction* in the plating department.

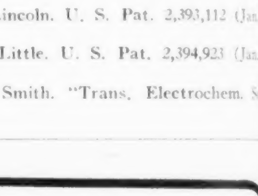
Rack coatings were described in detail in a paper by Critchfield,[207] in which the author explained the correct procedure for rack coating application. Elwin[208] patented a *plating rack* for uniform articles in a continuous plating or anodizing operation.

A patent was issued to Niles[209] for an *anode for chromium plating* baths having 6% to 12% silver and the balace lead, with a coating of lead chromate and silver chromate on the surface. A *horizontal type filter* for chemicals adapted for various filter media was developed by Alsop.[210] Croco[211] patented a *control motor* for plating baths, controlling the current density on continuous type processes. A *bus bar support* with an insulator for plating tanks and similar applications was designed by Scott,[212] and a *guide* for treating strip in continuous plating operations was patented by Venable.[213]

Bibliography

1. C. J. Slunder & H. A. Pray, "Ind. Eng. Chem.", **38**, 592 (1946).
2. E. M. Mahlia & N. A. Nielson. "Trans. Electrochem. Soc.", **89**, preprint 27 (1946).
3. H. Bandes. "Metal Finishing", **44**, 516 (1946).
4. C. B. Zitek & H. J. McDonald. "Trans. Electrochem. Soc.", **89**, preprint 24 (1946).
5. J. E. Stareck. "Trans. Electrochem. Soc.", **89**, preprint 6 (1946).
6. A. Weisselberg. "Trans. Electrochem. Soc.", **90**, preprint 1 (1946).
7. A. L. Peach. "Metal Ind.", **69**, No. 1, 14 (1946).
8. C. Hendershott, "Die Cast.", **4**, 70 (Apr. 1946).
9. R. S. Herwig. "Monthly Rev.", **33**, 609 (1946).
10. R. B. Mason. "Iron Age", **157**, 48 (Mar. 21, 1946).
11. J. Janota, Jr., & B. B. Button, Jr. U. S. Pat. 2,398,079 (Apr. 9, 1946).
12. M. A. Miller & W. E. White. U. S. Pat. 2,399,134 (Apr. 23, 1946).
13. G. P. Pilz & F. F. Farley. "Ind. Eng. Chem.", **38**, 601 (1946).
14. C. B. Durgin. U. S. Pat. 2,398,212 (Apr. 9, 1946).
15. C. N. White, M. L. Schwartz & G. F. Rouault. U. S. Pat. 2,402,793 (June 25, 1946).
16. J. B. Rust. U. S. Pat. 2,400,784 (May 21, 1946).
17. J. B. Rust. U. S. Pat. 2,400,785 (May 21, 1946).
18. J. B. Rust U. S. Pat. 2,400,786 (May 21, 1946).
19. P. M. Ruedrich. U. S. Pat. 2,392,1·2 (Jan. 1, 1946).
20. R. M. Thomas & C. W. Ostrander. U. S. Pat. 2,393,663 (Jan. 29, 1946).
21. R. M. Thomas & C. W. Ostrander. U. S. Pat. 2,393,664 (Jan. 29, 1946).
22. R. M. Thomas & C. W. Ostrander. U. S. Pat. 2,393,943 (Jan. 29, 1946).
23. P. W. Fischer & V. N. Jenkins. U. S. Pat. 2,403,067 (July 2, 1946).
24. J. J. Miskel, U. S. Pat. 2,403,293 (J 1946).
25. M. P. Kleinholtz. U. S. Pat. 2,403,928 16, 1946).
26. J. G. Cowley & F. McKnight. "Metal F ing", **44**, 150 (1946).
27. E. W. Wells. "Metal Finishing", 44 (1946).
28. F. V. Faulhaber. "Prod. Fin", 10 (1946).
29. H. Moore. "Metal Finishing", **44**, 247
30. E. E. Oathout. "Metal Finishing", 4 (1946).
31. F. Fogliasso, U. S. Pat. 2,392,909 (Jan 1946).
32. E. W. Hall. U. S. Pat. 2,395,325 (Fe 1946).
33. H. W. Buell. U. S. Pat 2,398,408 (Ap 1946).
34. B. F. Fowler. U. S. Pat. 2,402,131 (Ju 1946).
35. J. J. Manderscheid. U. S. Pat. 2,4 (July 9, 1946).
36. E. C. Murdock. U. S. Pat. 2,404,917 (Ju 1946).
37. S. S. Kistler. U. S. Pat. 2,406,385 (Au 1946).
38. S. S. Kistler. U. S. Pat. 2,408,319 (Sep 1946).
39. H. L. Kellner. "Met. Prog.", **50**, 1072
40. H. L. Beaver. "Prod. Fin.", **10**, 78 1946).
41. C. L. Faust. "Prod. Eng.", **17**, 449
42. C. Batcheller. U. S. Pat. 2,4 9,097 (Oc 1946).
43. "Iron Age, **157**, 65 (June 6, 1946).
44. R. P. Warren, "Monthly Review.", 3 (1946).
45. E. F. Fisher. U. S. Pat. 2,399,629 (Ma 1946).
46. R. L. Lincoln. U. S. Pat. 2,393,112 (Jan 1946).
47. W. P. Little. U. S. Pat. 2,394,923 (Jan 1946).
48. C. W. Smith. "Trans. Electrochem. S





preprint 25 (1946).
49. F. Hazel & W. Stericker. "Monthly Rev.", 33, 373 (1946).
50. S. Spring, H. I. Forman & L. F. Peale. "Ind. Eng. Chem." Anal. Ed., **18**, 201 (1946).
51. E. Hyler. "Organic Finishing", **7**, 25 (Apr. 1946).
52. C. Harris. "Metal Finishing, **44**, 328 (1946).
53. G. Black. "Mater. & Meth.", **24**, 95 (1946).
54. A. Campbell. U. S. Pat. 2,399,305 (Apr. 30, 1946).
55. H. E. Wassel. U. S. Pat. 2,393,866 (Jan. 29, 1946).
56. M. S. Evans & E. C. Stolberg. U. S. Pat. 2,394,514 (Feb. 5, 1946).
57. C. A. Stine. U. S Pat. 2,394,338 (Feb. 5, 1946).
58. B. J. Szatyn. U. S. Pat. 2,399,267 (Apr. 30, 1946).
59. N. Goldowski. U. S. Pat. 2,409,271 (Oct. 15, 1946).
60. H. R. Spence & H. W. Hooker. U. S. Pat. 2,395,694 (Feb. 26, 1946).
61. W. B. Hicks & D. J. Saunders. U. S. Pat. 2404,289 (July 16, 1946).
62. M. J. Myers. U S. Pat. 2,402,657 (June 25, 1946).
63. H. Kroll. U. S. Pat. 2,4 4,297 (July 16, 1946).
64. H. Kroll & M. Weisberg. U. S. Pat. 2,404,298 (July 16, 1946).
65. C. K. Turner. U. S. Pat. 2,398,059 (Apr. 9, 1946).
66. J. Troger. U. S. Pat. 2,395,593 (Feb. 26, 1946).
67. G. M. Croft. U. S. Pat. 2,395,397 (Feb. 26, 1946).
68. J. Nowatius. U. S. Pat. 2,392,176 (Jan. 1, 1946).
69. F. L. Pettingil. "Organic Finishing", **7**, 33 (June 1946).
70. F. L. Pettingil. "Organic Finishing", **7**, 37 (July 1946).
71. W. L. Keefer. U. S. Pat. 2,399,680 (May 7, 1946).
72. J. A. Heany. U. S. Pat. 2,395,479 (Feb. 26, 1946).
73. C. E. Archer. U. S. Pat. 2,392,897 (Jan. 15, 1946).
74. J. W. Rasmussen. U. S. Pat. 2,399,385 (Apr. 30, 1946).
75. W. M. Myers. U. S. Pat. 2,395,420 (Feb. 26, 1946).
76. C. H. Anderson. U. S. Pat. 2,395,160 (Feb. 19, 1946).
77. G. B. Hogaboom. "Metal Finishing", **44**, 198 (1946).
78. P. deLattre. "Sheet Met. Ind.", **23**, 685 (1946).
79. P. deLattre. "Sheet Met. Ind.", **23**, 899 (1946).
80. P. M. Fisk & F. F. Pollak. "Sheet Met. Ind.", **23**, 490 (1946).
81. M. Smith & R. Carno. "Prod. Fin.", **10**, 31 (Jan. 1946).
82. H. L. Petersen. U. S. Pat. 2,392,404 (Jan. 8, 1946).
83. W. H. Hill. U. S. Pat. 2,394,773 (Feb. 12, 1946).
84. E. K. Bolton. U. S. Pat. 2,402,596 (June 25, 1946).
85. A. D. Johnson. U. S. Pat. 2,406,379 (Aug. 27, 1946).
86. W. H. Hill. U. S. Pat. 2,394,773 (Feb. 12, 1946).
87. W. H. Hill. U. S. Pat. 2,394,774 (Feb. 12, 1946).
88. A. J. Saukaitis. U. S. Pat. 2,403,153 (July 2, 1946).
89. C. B. Young & C. Struyk. "Trans. Electrochem. Soc.", **89**, preprint 1 (1946).
90. A. E. Carlson & J. M. Kane. "Monthly Rev.", **33**, 255 (1946).
91. C. Struyk. "Monthly Rev.", **33**, 394 (1946).
92. M. B. Diggin. "Metal Finishing", **44**, 8 (1946).
93. H. J. Sedusky & J. B. Mohler. "Metal Finishing", **44**, 243 (1946).
94. H. J. Sedusky & J. B. Mohler. "Metal Finishing", **44**, 293 (1946).
95. W. P. Cottrell. U. S. Pat. 2,398,132 (Apr. 9, 1946).
96. M. B. Diggin. "Monthly Rev.", **33**, 513 (1946).

97. E. A. Ollard & E B. Smith. "Met. Ind.", **68**, 246 (1946).
98. E. A. Ollard & E. B. Smith. "Metal Ind.", **68**, 325 (1946).
99. E. A. Ollard & E. B. Smith. "Metal Ind.", **68**, 366 (1946).
100. J. H. Mort. "Iron & Steel", **19**, 189 (1946).
101. R. H. Burns. U. S. Pat. 2,393,516 (Jan. 22, 1946).
102. R. H. Burns U. S. Pat. 2,393,516 (Jan. 22, 1946).
103. R. H. Burns. U. S. Pat. 2,393,517 (Jan. 22, 1946).
104. R. M. Wick. U. S. Pat. 2,397,177 (Mar. 26, 1946).
105. G. L. Hendrickson. U. S. Pat. 2,405,302 (Aug. 6, 1946).
106. D. L. Griffith & L. G. Hendrickson. U. S. Pat. 2,396,569 (Mar. 12, 1946).
107. M. B. Diggin. "Monthly Rev.", **33**, 513 (1946).
108. K. M. Gaver. U. S. Pat. 2,406,072 (Aug. 15, 1946).
109. C. A. Mathews. U. S. Pat. 2,406,956 (Sept. 3, 1946).
110. S. Ruben. U. S. Pat. 2,393,068 (Jan. 15, 1946).
111. W. R. Meyer. "Monthly Rev.", **33**, 269 (1946).
112. G. C. Close. "Light Met. Age.", **4**, 8 (Mar. 1946).
113. M. Raskin. "Metal Finishing, **44**, 337 (1946).
114. N. Hackerman & D. I. Marshall. "Trans. Electrochem. Soc.", **89**, preprint 15, (1946).
115. W. E. Moline. "Monthly Rev.", **33**, 401 (1946).
116. E. A. Ollard & E. B. Smith. "Sheet Met. Ind.", **23**, 1129 (1946).
117. W. A. Crowder & L. E. Welch. "Ind. Plast.", **2**, 21 (Feb. 1946).
118. W. A. Crowder & L. E. Welch. "Ind. Plast.", **2**, 22 (Mar. 1946).
119. R. M. Wick. U. S. Pat. 2,392,871 (Jan. 15, 1946).
120. E. J. Roehl. "Die Cast.", **4**, 70 (July 1946).
121. V. Mattocotti. "Monthly Rev.", **33**, 494 (1946).
122. W. M. Phillips. "Monthly Rev.", **33**, 496 (1946).
123. B. Martin. "Monthly Rev.", **33**, 498 (1946).
124. M. B. Diggin. "Monthly Rev.", **33**, 500 (1946).
125. W. A. Wesley. "Monthly Rev.", **33**, 504 (1946).
126. W. C. Pinner. "Monthly Rev.", **33**, 506 (1946).
127. H. Brown. U. S. Pat. 2,402,801 (June 25, 1946).
128. M. Kosmin. U. S. Pat. 2,401,428 (June 4, 1946).
129. M. L. Freed & A. A. Stocker. U. S. Pat. 2,409,120 (Oct. 8, 1946).
130. G. Black. "Metal Finishing", **44**, 307 (1946).
131. M. L. Freed. U. S. Pat. 2,409,119 (Oct. 8, 1946).
132. M. B. Diggin & O. Kardos. "Metal Finishing", **44**, 429 (1946).
133. H. M. Haberman. "Metal Finishing", **44**, 525 (1946).
134. A. Brenner & W. A. Olson. U. S. Pat. 2,401,331 (June 4, 1946).
135. J. S. Hart & C. E. Heussner. "Monthly Rev.", **33**, 142 (1946).
136. P. J. LoPresti. "Metal Finishing", **44**, 288 (1946).
137. W. F. Hess & E. F. Nippes, Jr., "Weld. Jour.", **25**, 129 (Mar. 1946).
138. J. W. Andrews. U. S. Pat. 2,399,194 (Apr. 30, 1946).
139. N. F. Blackburn. U. S. Pat. 2,406,189 (Aug. 20, 1946).
140. E. W. Schweikher. U. S. Pat. 2,402,185 (June 18, 1946).
141. S. W. Baier. U. S. Pat. 2,397,522 (Apr. 2, 1946).
142. H. Roebuck & A. Brierley. "Jour. Electrodep. Tech. Soc.", **21**, 91 (1946).
143. R. M. Wick. U. S. Pat. 2,392,075 (Jan. 1, 1946).
144. J. L. Bray & R. E. Howard. U. S. Pat. 2,393,741 (Jan. 29, 1946).
145. A. G. Grady. U. S. Pat. 2,407,487 (Sep. 1946).
146. H. L. Cobb. "Monthly Rev.", **33**, 28 (
147. H. Brown & C. R. Hurley. U. S. Pat. 2,456 (Jan 8, 1946).
148. W. M. Martz. U. S. Pat. 2,409,983 (Oct. 1946).
149. A. H. Dukose. "Trans. Electrochem. S. **89**, preprint 7 (1946).
150. J. W. Hunter. U. S. Pat. 2,392,385 (Jan. 1946).
151. J. Koster. "Trans. Electrochem. Soc." preprint 26 (1946)
152. W. F. Grupe. U. S. Pat. 2,394,545 (Feb. 1946).
153. A. J. Mauger & A. H. Ward. U. S. 2,405,592 (Aug. 13, 1946).
154. C. H. Ward. U. S. Pat. 2,399,964 (May 1946).
155. R. A. Cresswell. "Iron & Steel", 19 (May 10, 1946).
156. H. R. Clauser. "Mater. & Meth.", 24 (1946).
157. E. M. Wise & R. F. Vines. U. S. 2,397,583 (Apr. 2, 1946).
158. B. Shomberg. "Metal Finishing", 44 (1946).
159. H. Narcus. "Metal Finishing", **44**, 240 (
163. P. Alexander & L. Cranstone. U. S. 2,402,269 (June 18, 1946).
161. A. R. Weinrich. U. S. Pat. 2,401,433 (Jun 1946).
162. F. C. Benner. "Mod. Plast.", **23**, 110 (
163. W. W. Hamel. U. S. Pat. 2,403,304 (May 1946).
164. D. B. McRae. U. S. Pat. 2,394,930 (Feb. 1946).
165. I. C. Clingan. U. S. Pat. 2,394,899 (Feb. 1946).
166. V. J. King. U. S. Pat. 2,393,640 (Jan. 1946).
167. M. F. Maher & F. J. MacStoker. "M Finishing", **44**, 153 (1946).
168. A. P. Shulze. "Metal Finishing", 44

1946).
169. H. L. Cupples. U. S. Pat. 2,401,053 (May 1946).
170. J. B. Mohler & J. Sernisha. "Metal Finishing", 44 (1946).
171. E. S. Spencer-Timms. "Jour. Electrodep. Tech. Soc.", **21**, 79 (1946).
172. S. Clabaugh. "Nat. Bur. Stds. Res. Paper" R P. 1694 (Feb. 1946).
173. G. Black & J. Sinner. "Metal Finishing", 44, 529 (1946).
174. A. L. Ferguson & E. F. Stephan. "Monthly Rev.", **33**, 45 (1946).
175. A. L. Ferguson. "Monthly Rev.", **33**, 166 (1946).
176. A. L. Ferguson. "Monthly Rev.", **33**, 279 (1946).
177. A. L. Ferguson. "Monthly Rev.", **33**, 620 (1946).
178. F. Gibadlo. "Iron Age", **157**, 58 (Apr. 18, 1946).
179. F. Todd. U. S. Pat. 2,405,532 (Aug. 6, 1946).
180. A. N. Hixson & W. M. McNabb. "Metal Finishing", **44**, 208 (1946).
181. H. E. Zentler Gordon & E. R. Roberts. "Trans. Electrochem. Soc.", **90**, preprint 2 (1946).
182. L. Silverman, V. Stewart & J. Davies. "Metal Finishing", **44**, 426 (1946).
183. D. G. Foulke, W. B. Meyer & B. C. Case. "Monthly Rev.", **33**, 836 (1946).
184. E. J. Serfoss & W. S. Levine. "Monthly Rev.", **33**, 1073 (1946).
185. J. Brown. U. S. Pat. 2,405,133 (Aug. 6, 1946).
186. H. K. Herschman. U. S. Pat. 2,402,926 (June 25, 1946).
187. B. A. Coss. U. S. Pat. 2,397,923 (Apr. 9, 1946).
188. H. Shaw. U. S. Pat. 2,396,394 (Mar. 12, 1946).
189. N. Hall & G. B. Hogaboom, Jr. "Metal Finishing", **44**, 2 (1946).
190. H. Silman. "Jour. Electrodep. Tech. Soc.", **21**, 65 (1946).
191. W. Blum. "Monthly Rev.", **33**, 411 (1946).
192. L. F. Oeming. "Monthly Rev.", **33**, 601 (1946).
193. N. Herda. "Sew. Wks. Jour.", **18**, 499 (1946).
194. W. J. Malcolmson & R. V. Miner. U. S. Pat. 2,398,712 (Apr. 16, 1946).
195. H. N. Gilbert. U. S. Pat. 2,398,738 (Apr. 16, 1946).
196. S. G. Hopkins. U. S. Pat. 2,408,515 (Oct. 1, 1946).
197. H. L. Tiger & P. C. Goetz. U. S. Pat. 2,397,575 (Apr. 2, 1946).
198. J. C. Lum. U. S. Pat. 2,408,227 (Sept. 24, 1946).
199. R. L. Heath, G. A. Fisher, Jr., & T. R. Holbrook. U. S. Pat. 2,408,931 (Oct. 8, 1946).
200. A. Doutz & G. C. Romig. U. S. Pat. 2,403,426 (July 2, 1946).
201. G. W. Jerstedt & J. C. Lum. U. S. Pat. 2,394,065 (Feb. 5, 1946).
202. Z. Irenas. "Metal Finishing", **44**, 195 (1946).
203. F. R. Morral. "Metal Finishing", **44**, 472 (1946).
204. R. M. Buck. "Iron Age", **158**, 46 (July 11, 1946).
205. G. B. Hogaboom, Jr., & N. Hall. "Metal Finishing", **44**, 63 (1946).
206. H. W. Sussman. "Metal Finishing", **44**, 108 (1946).
207. L. A. Critchfield. "Monthly Rev.", **33**, 152 (1946).
208. C. T. Elwin. U. S. Pat. 2,407,145 (Sept. 3, 1946).
209. J. B. Niles. U. S. Pat. 2,398,110 (Apr. 9, 1946).
210. S. Alsop. U. S. Pat. 2,392,354 (Jan. 8, 1946).
211. C. P. Croco. U. S. Pat. 2,404,948 (July 30, 1946).
212. W. M. Scott, Jr. U. S. Pat. 2,396,131 (Mar. 5, 1946).
213. W. M. Venable. U. S. Pat. 2,395,437 (Feb. 26, 1946).